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RED SEA PEN.

NATURE DISPLAYED

IN THE

HEAVENS,

AND

ON THE EARTH,

ACCORDING TO THE LATEST

OBSERVATIONS AND DISCOVERIES.

By SIMEON SHAW, L.L.D.

Full Nature swarms with life; one wondrous mass
Of animals, or atoms organized,
Waiting the vital breath, when parent Heaven
Shall bid his Spirit blow. The hoary fen,
In putrid streams, emits the living cloud
Of pestilence. Thro' subterranean cells,
Where scorching sun-beams scarce can find a way,
Earth animated heaves. The flowery leaf
Wants not its soft inhabitants. Secure,
Within its winding citadel, the stone
Holds multitudes. But chief the forest-boughs,
That dance unnumbered to the playful breeze,
The downy orchard, and the melting pulp
Of mellow fruit, the nameless nations feed
Of evanescent insects. Where the pool
Stands mantled o'er with green, invisible,
Amid the floating verdure millions stray.
Each liquid too, whether it pierces, soothes,
Inflames, refreshes, or exalts the taste,
With various forms abounds. Nor is the stream
Of purest crystal, nor the lucid air,
Though one transparent vacancy it seem,
Void of their unseen people.

Thomson.

IN SIX PARTS.

PART III.

LONDON:
PRINTED FOR SIR RICHARD PHILLIPS.
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TO BE HAD OF J. CUMMING, DUBLIN; OLIVER AND BOYD, EDINBURGH;
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1823.

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J. and C. Adlard, Printers, 23, Bartholomew Close.

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DESCRIPTION OF THE ENGRAVINGS IN PART III.

MICROSCOPIC OBJECTS.

It has been preferred to collect together in one series of plates, the various objects of microscopic observation, though they belong to different kingdoms and orders. The human eye is calculated to see objects distinctly at a distance not less than eight inches. The size or angle is inversely proportioned to the distance. Thus, at eight inches an object appears of certain standard dimensions, but at sixteen inches is only half those dimensions, while at four inches it is double, at two inches quadruple, and so on. In descending, however, to small distances, the object becomes indistinct. The purpose of a microscope is, therefore, to produce such a new disposition of the light, as enables the eye to produce a perfect image on the retina. For example, the eye can appropriate rays which flow into it parallel, or nearly so; but, if the eye is too near the object, the rays diverge too widely for its powers, and an indistinct picture is produced on the retina. In these circumstances, a convex glass enables the eye to become near-sighted, by rendering the rays parallel when they emerge from the glass, and the eye then sees as distinctly as at the distance of eight inches; but the object is as much larger as eight inches are proportioned to the distance of the glass lens from the object: such is a simple microscope. A combination of lenses increases the magnifying power, by first producing a magnified image, which magnified image another lens enables the eye to approach, and a multiplied power is the consequence. A simple microscope or single lens enables the eye to approach the object, and a compound microscope enables the eye to approach an image made by the single lens; and a solar microscope operates on the last principle, but improves the effect by increasing the quantity of light. The power of microscopes is usually estimated by the increasing bulk, which is the cube of the length and breadth. Thus, if we are enabled, by a lens, or combination of lenses, to view a cubic object within a quarter of an inch, its length is augmented in appearance thirty-two times, because we are thirty-two times nearer than at the distance we usually view it; but its superfices are increased thirty-two times thirty-two, or 1024 times, and its solidity or bulk thirty-two times 1024, or 32,768 times: such are the wonderful powers of the microscope. If the quantity of light could be augmented in the same proportion, we should thus see an object, only that small part of a cubic inch, as distinctly as we see a cubic inch at the usual distance of eight inches.

CAMPANULATED TABULARIA.

This is one of the most beautiful of the polypus congregations. It is found in clear stagnant waters, and lives in a congregated manner, several animals, to the number of ten, twelve, or fifteen, inhabiting a common receptacle. It is generally attached either to the small fibres of roots projecting into the water, or to the stems of aquatic plants. The body is transparent, of a sub-cylindric tubular form, and is included in a larger or exterior tube, from which the head or upper part is at pleasure protruded. When disturbed, the animals withdraw into the larger or exterior tubes; they, however, seem impatient of confinement, and are commonly seen with their heads expanded. They are found in various parts of the metropolis.

SPONGES.

Sponges, according to Dr. Peyssonel, and said to be productions and habitations of small worms, being the first approach towards the elegant corals; and the same kind of animal forms the four principal species of sponge—the tube sponge, the cordlike sponge, the digitated sponge, and the honeycomb sponge; the interstices and tubes of which are labyrinths filled with these insects, and whose juices make the sponge increase or grow, just as bees, wasps, and wood-lice, increase their nests and cells. But Mr. Ellis, of the Royal Society, is of opinion that the sponge itself constitutes the animal, and that the insects found in them only make use of the sponge as retreats. He considers the sponge as the lowest appearance of animal life, and as the link which connects vegetable with animal, the hole being so many mouths receiving nourishment, and discharging excrements. He states that the holes contract and dilate themselves, and that no polypi or minute animals appear at their mouths, as would be the case if the sponge were merely their habitation.

The left-hand figure in the engraving is the branched English sponge; on the surface of which are rows of small papillari holes, through which the animal receives its nourishment. The small figure is the downy branch Sussex sponge. The third figure is of a firm but elastic texture, full of holes guarded by minute spines, and brought from Norway. The right-hand specimen, also from Norway, is called the sea-fan sponge, and all its pores are surrounded with spiculæ.

SILVER SEA-PEN.

Of all the pennulata yet known, this is one of the largest and most curious in its appearance; being of a beautiful silvery white, elegantly striated on each of the feather-like processes, with lines or streaks of the deepest black. It is extremely rare, and is a native of the Indian Seas. The accompanying engraving is copied from a fine specimen in the British Museum.

RED SEA-PEN

Forms a genus of loco-motive zoophyte, and swims in the manner of a fish. It is generally of a very beautiful appearance, and is found on the British coast. The animal consists of a flattened stem or body, which is furnished with an internal bone, and dilates into an expanded part, consisting of several pinnæ, or lateral branches, which are divided on their inner edges into a number of tubular processes, through each of which is protruded a part of the animal, resembling the head of a hydra or polype: the whole animal may, therefore, be considered as a very compound or ramified union of polypi, the bodies of which are contained in the naked part or stem, and from thence ramify into a vast number of processes, each furnished with its particular head. The animal emits a very strong phosphoric light, and it is even so luminous, that it is no uncommon circumstance for the fishermen to see the fish which happen to be swimming near it merely by the light of the pennulata. Its colour is a bright red or crimson, and the general size that of the figure

Mr. Ellis, in the Philosophical Transactions, has published some specimens of this extraordinary animal, of a kidney-shaped form, and observes that it nourishes and supports itself by the succours of polype filaments, which we have expressed in the engraving in a magnified size. By these they take in their food and discharge the exuviæ. In case of danger these little succours are drawn in.

POLYPI.

These wonderful creatures, who appear to form a distinct branch of existence, and whose habits are totally unlike locomotive beings, present themselves in so many different shapes in the sea, that it would be endless to pursue them in all their protean forms and various structures; but enough is given in these engravings to fill the reader with delight and astonishment. We have traced them from their naked form in our ditches, to their surprising fortifications in various structures of substances as hard as ivory, where they set at defiance every enemy, yet are able to issue forth in search of their own prey. At the same time, such is their power of multiplication, and such their industry, that they fill up the bottoms of the vast ocean, and thereby appropriate to themselves perhaps as large a portion of the surface of the globe as is occupied by the land itself. In this manner Divine Wisdom humbles the pride of man, by means apparently the most insignificant.

Fig. 1 represents a polypus sticking to a twig, A, B; its body very slender. From A is expanded several horns, A, C, which serve it instead of legs and arms, and are more slender than the body. The mouths of the polypus are at C. The stomach occupies the whole length of the body, which is a pipe, or sort of gut, open at both ends. They can stretch themselves to the length of an inch and a half, but they are generally about three-quarters of an inch long; and they can contract themselves to the twelfth of an inch, or to any intermediate length. One species can extend its arms seven inches, or contract them at pleasure; and the number of the arms are seldom fewer than six. They are capable of assuming all manner of forms. They do not swim, but crawl upon all bodies they meet with in the water; and their common position is to fix them to their posterior end, B, and stretch their body and arms forward into the water. As soon as an insect touches one of the arms, it is caught, and carried to the mouth by contracting or bending the arm; but, if the prey make resistance, other arms are brought into action. Thus a polypus can master a worm twice or thrice as long as itself. He draws it to his mouth, and swallows it whole, and the stomach extends so as to receive it; he then sucks it, and voids the remainder at B. They eat more in hot weather, and grow in proportion to what they eat; yet they can fast for months. Each individual produces young ones from all the exterior parts of its body, which are stems, from which issue the young ones as branches. The young ones themselves sometimes bring forth others before they are severed from the parent. If they are kept warm and have plenty of food, they multiply prodigiously. If the polypus be cut into two parts transversely, each becomes a complete polypus, and the end at A lengthens itself, creeps and eats on the same day. On the part which has no head, one grows, a mouth forms itself, and shoots forth arms, in summer, in twenty-four hours; and the new head is perfected in a few days; both the polypi being as complete in all their functions as though they had not been cut. Even if a single one be cut into fifty pieces, each of them shoots out into perfect polypi. It may also be cut into two, lengthways, when the edges of the half-pipes close, and the animals become perfect in an hour; additional arms growing in a few days. Most ditches, where water is stocked with small insects, produce them.

Fig. 2. A polypus magnified.

—— 3. The same insect, when it has contracted itself, magnified.

—— 4. A polypus with a young one growing at its side.

—— 5. The polypus swallowing a worm endways, grasping the remainder to push it into its stomach.

—— 6. Its mouth extended to receive the remainder of a worm.

—— 7. After it has swallowed the worm.

—— 8. One of the arms of the polypus very much magnified.

—— 9. Represents the clustering polypus considerably magnified; a species which unite in this manner to one stem, and then separate.

—— 10. Represents another of the clustering polypi, drawn in two or three days after it began to form itself. It is much magnified; and one of the branches at little *a* is represented as partly contracted from some external cause.

—— 11. A clustered polypus, of its natural size, extending itself. This specimen was brought up from 236 fathoms, in lat. 79° north, about eighty miles from Greenland, and was at first taken for a fine full-blown flower.

—— 12. Represents the same polypus, with the tentacula laid straight. M is a stem of ivory, six feet long; N is the muscular base where the bodies of the polypus unite.

The polypus appeared to reside at the top of the stem, as on a branch of coral, and was united to it by a membrane like a bladder. Their disposition on the top of the stem is represented at Fig. 11, where ten occupy the upper circle, nine the next, and four in the centre.

Corals.

Coral is a marine production, in shape resembling a shrub stript of its leaves, as in fig. 13. It has no root, but is supported on a broad foot, which adapts itself so firmly that it is impossible to disengage it, as N, N, fig. 14; and the thickness seldom exceeds an inch. Fig. 15 represents a branch of coral with its coating taken off, to show its tubular structure. The coral derives no nutriment from the root; for, if broken off, it grows equally well. Its greatest height is about twelve inches. When the bark is broken off, a small worm enters the body of the coral, which makes itself roundish cells, and others pass through it in straight cylindrical holes. On the bark appear small tubercles, as in fig. 13, or in fig. 15. The bark of the coral ends at the extremity of these parts. From these tubercles proceed hollow cells, extending to the foot of the coral, in which are lodged polypi, plainly visible, through a microscope, having eight equal rays like a star, and nearly conical. These may be seen when the coral is just taken from the sea, and placed in sea-water; otherwise the polypus draws itself in, as a snail draws in its horns, when it resembles a drop of milk.

The Madrepore.

Fig. 16. This substance is as hard as coral, but white and wrinkled. In its centre is a cylinder, often pierced by two or three holes, and from this cylinder are detached seventeen radiated divisions which run to the circumference, and these again are intersected by divisions, so that the whole plant is filled with cavities, as in Fig. 17, where a part of the bark is taken off to shew the internal construction. The branches, G, G, Fig. 16, are conical, and the basis of the cone is formed by the summit of the branches, E, E, and every one of the summits has wrinkles on its outside, and each wrinkle answers to a division within. In every one of these divisions is found a polypus, magnified in fig. 18. Three different parts compose this wonderful little animal. The feet are arranged all round, and on the outside are seen ten cavities, in which are lodged the animal's heads, which have prickly rays, as in the centre, where it has a continual oscillatory motion from right to left. It is extremely tender, transparent, and beautifully coloured. The entire of these plants appear the progressive production of these small insects, which includes the various vermicular tubes found in the sea, as Madrepores, Millepores, Lithophytes, Corallines, and the various shell-fish which inhabit the sea without changing their place.

Corallines.

Of these beautiful and extraordinary productions of nature, it is difficult to convey an adequate idea by an engraving. They are extraordinary, because the productions of extremely small insects, which in these forms construct rocks dangerous to navigation, and, ultimately, islands, which in time become habitations of men; such being the origin of most of the islands in the South Seas. The specimens represented are of the genera *madrepora* and *millepora*. The 4th figure in the plate represents the celliferous or fleshy coralline; each cell of which affords habitation to a polypus.

Fig. 19, is the tubular coralline, in effect the same as a coral, but carried up in different branches by polypi, whose arms are seen stretching from the apex of each tube.

—— 20, represents the small branches which attach to oyster-shells, but which, in truth, are the productions and residence of polypi; as may be seen in fig. 21, where a branch is magnified, and the arms are seen extended; and fig. 22 further illustrates the same fact, by showing the tubular construction of the base of the same coral, where it attaches to the oyster-shell.

THE BELL-FLOWER POLYPI.

These extraordinary creatures dwell in colonies, as they are called, or as a family in a common receptacle, and adhere to duck-weed and other aquatic plants. When the weeds are put for three or four hours in glass vessels in a strong light, the polypi will beautifully extend themselves out of their transparent cases, as in Fig. 4 and 5. A colony never exceeds fifteen; and, when it has increased above that number, the bell or case splits gradually, as in fig. 6, and it afterwards constitutes two separate colonies.

a, the head, resembling a horse-shoe.
b, *v*, the arms.
c, the neck.
d, the œsophagus.
e, the stomach.
f, the intestine.
g, the anus.
h, *i*, that part of the common bell which surrounds the animal, and closes upon it when it retires downward.

Fig. 5 represents what is called a colony of these animals, standing erect, with the animals out of the common envelope.

Fig. 6 represents the extraordinary process of a colony splitting or dividing into two parts, when it has become too numerous.

Water Flea and Globe Animal.

The Water Flea is a lively and curiously formed creature, found in all stagnant waters, neglected water-butts, &c. (Fig. 2.)

The Globe Animal abounds in water, revolving in all directions. (Fig. 3.)

EGGS OF THE PHALÆNA NEUSTRIA.

Fig. 7 represents the eggs of the moth or phalæna neustria, as taken from the tree to which they adhere, and magnified. The strong ground-work, visible in many places, is the gum by which they are glued together; and strengthened by a very tenacious substance interposed and filling the vacant spaces between the eggs. Fig. 8 shows a vertical section of the eggs, exhibiting their oval shape. Fig. 9 an horizontal section through the middle. These eggs appear beautiful through the microscope: *a*, *b*, *c*, represent the objects in their natural state.

EELS IN PASTE.

Fig. 1. *The Eel in Paste magnified.* Paste turned soon becomes full of these insects, in the manner represented in the adjoining division of the plate. Similar insects also appear in vinegar. They flourish for a considerable time in the paste if it is kept moist. In fig. 1 in the other plate the insects are represented as in the paste.

WHEEL INSECTS.

The Wheel Animal. This animalcule appears in rain-water, which stands in contact with lead, and is remarkable for its various forms, its vivacity in the water, and its tenacity of life out of the water, in a completely torpid and dry state, when it assumes the form of a sphere, as in Figs. 2 and 3.

Fig. 4, 5, is its maggot state; and all the other figures in the plate represent its various extraordinary changes between the globular and the maggot state. When it has been several months out of water in the globular state, it becomes the size of a grain of sand; but, on being put into water, in half an hour it begins to move, and assumes the maggot form, pushing out its wheels, and swimming through the water, or fixing itself by the tail and working its wheels. This wheel-work, which is represented at the crown of several of the figures, is a most curious piece of mechanism, and assumes a great variety of forms, sometimes of entire circles, formed with small teeth or cogs; sometimes like the battlements of a tower, and others like a gothic crown or clublike mallets; the assemblage of which make regular rotations, and their forms seem to be connected with the animal's pursuit of prey. They appear very sagacious; for, on touching the water, they instantly draw in the wheels: yet, small as they are, other insects infinitely smaller may be seen in the water, on which they prey. The heart of the animal may be seen through the back in regular action, and the abdomen, stomach, and intestines, are distinguished in action. The abdomen is capable of stretching, as in the three last figures, and receiving the upper parts of the body.

THE POINT OF A NEEDLE, A FULL-POINT, AND FLAKES OF SNOW, MAGNIFIED.

This plate represents *the Point and Surface of a fine Needle magnified; the Crystallizations of Snow* and *the Full-Point used in Printing.* The exactness of nature, compared with the coarseness of art, are well worthy of attention.

THE MITES IN CHEESE MAGNIFIED.

After viewing these creatures, there are few persons who will not be disgusted at the thought of eating them, or not shocked at the unthinking practice of roasting them alive.

A FLEA MAGNIFIED.

The power of this creature to leap in its surprising manner, is evinced by the length and number of joints in its legs. The hooks at the end of its claws, and other circumstances of construction, are worthy of notice.

The head is small and shelly; a quick, round, and beautiful black eye on each side, K; in the middle is a round black spot, the pupil, encompassed with a greenish glittering circle or iris, as bright and vivid as the eye of a cat.

Behind each eye is a small cavity, at L, with a certain thin moving film, beset with many small transparent hairs; probably the ear.

From the snout proceed the two fore-legs, between which are two long small feelers, M,M, each having four joints, and much hair below; and almost between these is the proboscis, or piercer, N, N, O, consisting of a tube, N, N, and a tongue or sucker O, protrusive or contractile at pleasure. It has also two chaps or biters, shaped and opening like the blades of a pair of round-topped scissars; with which, it penetrates the skin of living creatures, and leaves a round red spot, commonly termed a flea-bite.

The parts A,A, of the fore-legs, lie within the parts B,B; and those again within the upper and stronger parts, C,C, parallel to each other. The parts of the two next legs are disposed contrariwise; the parts D,D, are placed without the parts E,E, which are yet more outward than those parts F, F. In the hinder legs the parts G, H, and I, bend one within another, like the limbs of a double-jointed rule; or like the foot, leg, and thigh, of a man. To leap, the flea folds up these six legs, and extends them all at the same instant; and, its whole strength being thereby exerted at once, the little body is carried to a considerable distance.

A LOUSE MAGNIFIED.

The head A, is rather conical, but little flatted: on each side where whitest, is a large black shining eye, B,B, very protuberant, and encompassed with small hairs, situated a little behind the head, where are the ears of other creatures; and, where one might expect to find the eyes, a couple of horns protrude, as C, C, extending so as to defend the eyes from being injured by the surrounding hairs; each horn has four joints, fringed with small bristles.

The head tapers from the horns to the snout D, which ends in a sharp point, and seems a tubular instrument; the louse sucks the blood, on which it feeds and lives.

There seems a resemblance of chaps or jaws, at E, E, yet in another view those appearances are not discernible.

There appears, at A, some contrivance like a pump, a pair of bellows, or heart, which, by a very swift and alternate dilation and contraction, draws up the blood, and forces it into the body. When viewed attentively while sucking, it cannot be perceived that any more of its nose is thrust into the skin than the tip of the snout, D; nor does it cause the least pain, although the blood runs through its head quickly and freely; which proves that blood-vessels are dispersed through every part of the skin, even into the cuticula; for, was its whole snout thrust in from D to C, C, it would not amount to the supposed thickness of that tegument; the length of the whole nose not exceeding the three-hundredth part of an inch.

The louse has six legs, strongly jointed to the thorax: on which, for each pair, a kind of division appears, as *e*, *e*, *e*. They are covered with a transparent shell, and jointed like the legs of a crab or lobster. Each is divided into six parts, with several small hairs issuing, and end with two unequal claws, adapted to the particular exigences of the animal, to walk either on the skin or hair. The lesser claw, *a*, being much shorter than the other claw, *b*, when it walks on the skin, the shorter claw does not touch, and then the feet are like those of the mite and many other insects: whereas, when among hairs, the longer claw bends round by its small joints, and, meeting with the shorter, both together can take hold and grasp a hair, as with a thumb and finger, after the manner represented in the figure, where F, F, F, a human hair, is so grasped and held by this creature that it is in no danger of falling.

The belly is very transparent; but its covering resembles a skin rather than a shell, being grained like the skin of a man's hand, and, when the belly is empty, very flaccid and wrinkled. The white spot I, I, may be the liver or pancreas, which, by the intestinal peristaltic motion, is moved a little to and fro, with a thronging or justling motion.

After one had fasted two days, all the hinder parts appeared lank and wrinkled: the white substance I, I, scarcely moved; most of the white branches disappeared, as did also the redness or sucked blood in the intestines; the peristaltic motion was scarcely discernible; but, upon being suffered to suck, the skin of the belly, and the six scalloped embossments on either side, were quickly filled out; the stomach and intestines seemed quite crammed, and multitudes of white vessels appeared, full and turgid; the peristaltic motion quickened, as likewise the justling motion of the substance I, I.

Near the bottom of the belly, beset with hairs or bristles, appears the anus, K, whose aperture is occasionally closed by two parts, L, L, below. At the extremity of the tail, two bodies, M, M, resemble the rump of fowls, whence issue a number of sharp hairs.

THE BLUE-BOTTLE, OR COMMON FLESH FLY.

Fig. 3. *The Blue-Bottle, or common flesh-fly*, enlarged by the microscope, so as to show distinctly all its particular and minute members and ornaments. A, A, are its protuberant and pearled eyes, or hemispheres, ranged in triangular order, which make a considerable part of the head, though smaller than those of the

drone-fly. A scaly prominent front between the eyes, adorned and armed with large tapering sharp black bristles, growing in rows on each side, and bending towards each other near the top, form an arch of bristles, that almost covers the front B, C, a projecting part at the anterior end of this arch, and about the middle of the face, two little oblong bodies, D,D, like the apices or pendents in lilies, each having one small joint to C, and another to the front part, B. These, in the head of the drone-fly, are called horns, from their resemblance to the horns of some kinds of beasts. E, E, are brushy bristles or feathers, like the tufts of a cock-gnat, growing from the upper part and outsides of the horns D, D. F, F, are four strong bristles, placed two and two, and bending towards each other, just above the opening of the mouth. G, H, I, is the fly's proboscis or trunk from the middle of the mouth. It seems hollow, and by several joints is moved, thrust out, or pulled in, at pleasure. At H is a knee, or bend from thence to the extremity, slit into two lips, H G, H I, on their outer sides covered with large hairs; though those on the upper part of the proboscis are very small. These lips easily open or shut, and hold or take in little pieces of solid food; but, when the fly sucks any thing, she spreads them open, and applies their hollow part perfectly close to the surface; thus they serve to pump up the juices of fruits or other liquors. K, K, are two little hairy oblong bodies, in the mouth, growing from each side of the proboscis. These parts are differently shaped, and much larger in the head of the drone-fly, marked G, G. Hooke imagines these may be the organs of smelling.

The middle part or thorax, is crustaceous, strongly made, rounded on the top, and covered with large, long, black bristles, in parallel order, like the quills of a porcupine, all pointing towards the tail. From the hinder and under part grow three large legs on each side, covered with a strong hairy shell, and resembling the legs of a crab or lobster. Each leg is jointed, and of eight parts, 1, 2, 3, 4, 5, 6, 7, 8; on the eighth grow the soles or spunges and claws. Of these six legs, the fly seldom employs more than four to walk with; the two former serve instead of hands, to take up any thing to eat, to clean her mouth, eyes, wings, and body, and for many other purposes. L, L, are the two wings fastened with strong joints to the upper part of the thorax.

The Foot of a Fly.

Fig. 1. The *Foot of a Fly*, magnified.

The two talons are handsomely shaped, as A, B, A, C, and very large in proportion to the rest of the foot. The larger part, A to *dd*, is bristled all over; but thence towards C and B, the tops and points which turn downwards and inwards, are smooth and very sharp. Each talon moves on a joint, A, and can be shut or opened at pleasure; so that, the points B and C, having entered the pores of an object, and the fly endeavouring to shut its talons, they not only draw against and so fasten each other, but also pull forwards all the parts of the foot; and the tenters, or sharp points, G,G,G,G, run into the pores, where there are any; or, on a soft place, make their own way.

Something similar may be discerned by the naked eye in the feet of a chaffer; and, if suffered to creep over the hand, or any tender part of the body, its manner of stepping will be as sensible to the feeling as to the sight. But, as the chaffer, notwithstanding its contrivance to fasten its claws, often falls in attempting to walk on hard and close bodies; so likewise would the fly, had not nature furnished its foot with a couple of pattens or spunges, D,D.

From the under part of the last joint of the foot, K, proceed two small, thin-plated, horny substances, each consisting of two flat pieces, D,D. These, about F,F, *f*,*f*, seem flexible, like the covers of a book, by which the two sides *ee*, *ee*, do not lie always in the same plane, but sometimes shut closer, so that each can take a little hold. But the bottoms of these spunges are also beset with small tenters, like the wire teeth in a wool-card, their points inclining forward; by these the two talons draw the foot forwards, and the spunges being applied to the surface of the body upon which the fly walks, with the points of all their bristles standing forwards, and outwards, as *o*, *o*, *o*, *o*, *o*, if that surface has any irregularity, or gives way, the fly can suspend itself, or walk on it easily and firmly. And its ability to walk on glass proceeds partly from some little ruggedness thereon, but chiefly from a tarnish, or dirty smoky substance, adhering to the surface; so that, though the sharp points on the spunges cannot penetrate the surface of glass, it may easily catch hold of the tarnish contracted. *y*, *y*, *y*, are some very long, stiff, sharp-pointed hairs or bristles.

Fig.2. What a wonderful complication of admirable contrivance and divine wisdom and goodness is thus displayed in the structure of so simple and inconsiderable a thing as a fly's foot! Is it to be supposed that so much wisdom was exerted for the convenience of an animal for the mere purpose of being wantonly destroyed by man? Are we not bound by our homage to the Creator to respect all his works, by allowing them to fret out their little hour upon the stage of life unmolested; except so far as they unquestionably militate against our own existence?

The Wing of a Fly.

A whole wing, consists of a fine, thin, transparent skin or membrane, variously folded, plaited, and distended over the whole area; and several bones, ribs, or stems, with great regularity and contrivance, disposed so as to strengthen and support the wing, and determine its proper figure.

The ribs of the wing are covered with little scales; but the fore edge is armed with little bristles, all whose points are directed towards the tip; and even the whole edge all round the wing is covered with a small fringe, of shorter and more slender bristles.

LARVA OF THE MUSCA CHAMÆLEON.

Fig. 1 represents the larva of the *musca chamæleon*, an aquatic insect. Viewed by the naked eye, it appears composed of twelve annular divisions, separating it into an head, thorax, and abdomen; but it is not easy to distinguish the two last parts, as the intestines lie equally in both. The tail has a fine crown or circle of hair, *b*, by which it is supported on the surface of the water, the head and body hanging down, in which posture it will remain a considerable time; to sink to the bottom, it closes these hairs. Fig. 2 forms an hollow space, including a small bubble of air; by enlarging or diminishing which, it can rise or sink in the water. When the bubble escapes, the insect can replace it from the pulmonary tubes, and sometimes much air may be seen escaping from the tail into the atmosphere, when the worm is placed in a glass of water. The snout is divided into three parts, the middle one immoveable; the others from its sides moveable and vibratory, like the tongues of lizards or serpents; in which lies most of the creature's strength; for it walks upon them when out of the water, appearing to walk on its mouth, and to use it as the parrot does its beak in climbing.

Fig. 3 is its appearance through a microscope. It grows narrower towards the head, is largest about the thorax, converges along the abdomen, and terminates at length in a sharp tail surrounded with hairs. The twelve annular divisions are now very visible, and marked by numbers. The skin appears hard and resembling shagreen, thick set with grains equally distributed. It has on each side nine holes, or spiracula, for breathing, but none on the tail division *a*, nor any easily visible on the third from the head. The latter has some very small holes under the skin, near the place of the embryo wings of the future fly. Caterpillars, in general, have two rings, without these spiracula, perhaps because they change into flies with four wings; whereas this worm produces a fly with only two. The skin of the larva is adorned with oblong black furrows, spots of a light colour, and orbicular rings, whence there generally springs a hair; but only those hairs which grow on the insect's sides are represented in the figure. There are also some larger hairs, as at *c c*. The difference of colour arises only from the quantity of grains in the same space: for where they are in numbers the furrows are darker, and paler where they are less plentiful.

The head, *d*, is in three parts, and covered with a skin having scarcely any discernible grains. The eyes are rather protuberant, and lie near the snout, which has two small horns, *i i*. It is crooked, and ends in a sharp point *f*. The legs are near the snout, between the sinuses of the eyes. Each leg consists of three joints, the outermost covered with stiff hairs like bristles, *g g*. From the next, composed of a black substance, of a hardness between bone and horn, springs a horny bone *h h*, used as a kind of thumb, and the third joint is of the same nature. To distinguish these parts, the upper sides of the mouth and eyes must be separated; after which, by the microscope, we may perceive the leg articulated by some particular ligaments, with the portion of the insect's mouth which answers to the lower jaw. We may also discern the muscles which move and draw the legs up into a cavity between the snout and those parts of the mouth near the horns *i i*. The insect walks upon these legs, in the water and on the land. It also uses them in swimming, keeping its tail on the surface, and hanging down the rest of the body; when its only perceptible motion is in its legs, which move in a most elegant manner.

The snout is black and hard; the front, *f*, sharp and hollow; and the back part quite solid, somewhat globular; and three membranaceous divisions may be perceived on it; by means of which, and the muscles in the snout, the creature can contract or expand it at pleasure. The extremity of the tail is surrounded with thirty hairs, and the sides adorned with others smaller: here and there the large hairs branch out into smaller ones. All have their roots in the outer skin, here covered with rough grains, observed when cut off and held against the light upon a slip of glass. At the extremities of the hairs are grains, like those on the skin; and in the middle of the tail is a small opening, with minute holes, for the insect to take in the air it breathes. These hairs, however, are disposed in the regular order represented in the figure, only when the insect floats with the tail and its hairs under the surface. The least motion of the tail downward produces a concavity in the water, and it resembles a wine-glass. It answers the double purpose of swimming and breathing, and through it the insect receives the principle of life and motion.

These creatures are found in shallow standing waters in June. They crawl on the grass and other plants which grow in such waters, and often float on the surface, the head and thorax hanging down; in which posture, in search of food, commonly a viscous matter, they turn over the clay and dirt with their snout and feet.

The Wing of an Earwig.

Fig. 4. The wing of the earwig magnified. When the earwig uses its wings, which is not often, and closes them again, they fold them back in parts, and shut up the ribs like a fan.

The other objects on this plate represent three insects of extraordinary structure.

The Stick Phasm.

Fig. 5. The stick phasm, a singularly shaped creature, and one of the sportive varieties of nature.

The Praying Mantis.

For a description of this animal, see page XXVII.

SECTION OF AN ELM BRANCH.

Fig. 6 represents the section of a *small elm-branch*, the variations of which, from the ash and oak, given in the subsequent plates, merit special notice.

Scales of different Fish.

Fig. 1 shows the *Scale of a Sea-perch*, found on the English coast; the natural size is exhibited at *a*.

Fig. 2 is the *Scale of a Haddock* magnified; its natural size is within the circle *b*.

Fig. 3, the *Scale of a Parrot-fish* from the West Indies magnified; *c*, the natural size.

Fig. 4, the *Scale of a kind of Perch* in the West Indies magnified.

Fig. 5, part of the *Skin of a Sole-fish*, as viewed through an opaque microscope; the magnified part, in its real size, is shown at *e*.

SECTION OF AN OAK BRANCH.

Fig. 6. *Section of an Oak-branch*, worthy of being compared with that of the ash and elm, in which the differences are considerable, and interesting; although, at a rough glance, they present the appearance of structures very similar.

Cornea of the Libellula.

Fig. 1 shows part of the *Cornea of the Libellula* magnified. In some positions the sides of the hexagons appear of a fine gold colour, and divided by three parallel lines. The natural size is at *b*.

Lobster's Cornea.

Fig. 2 shows the part *c* of a *Lobster's Cornea* magnified. As these animals have no muscles to turn their eyes in different directions, they are provided with an immense number of separate lenses, by means of which, a distinct figure of the object is produced on the retina, by some one of them, whatever be the direction of the eye; and they are consequently enabled to see distinctly on any side. Such is the opulence of their structure, despised and abused as they are by the pride and cruelty of man.

Horn of the Barnacle Shell-Fish.

Fig. 3 shows one arm or horn of the *Lepas antifera*, or barnacle shell-fish, magnified. Each horn consists of several joints, and on the concave side of each joint are long hairs: the arms appear rather opaque, but may be rendered transparent and most beautiful by extracting from the whole length of the interior cavity a bundle of longitudinal fibres. Needham thinks that the motion and use of these arms may illustrate the rotatory motion in the wheel-animal.

Apparatus of the Gad-Fly.

Fig. 4 shows the apparatus of the *tabanus*, or gad-fly, by which it pierces the skin to suck the blood of horses and oxen. The whole is in a fleshy case; the feelers of a spongy texture and grey colour, covered with short hairs, are united to the head by a small joint. They defend the other parts, being laid side by side whenever the animal stings, and thus prevent external injury. The wound is made by the two lancets, of a delicate structure, but very sharp, like the dissecting knife of anatomists gradually thickening to the back. The two jagged or toothed instruments appear intended to enlarge the wound, by irritating the parts round it: their hard and horny texture may also serve to defend the softer tube, being of that form to admit the blood and convey it to the stomach. This part is totally inclosed in a line, which entirely covers it. The natural size of this apparatus is inclosed in the small circle.

Skin of a Lump-Fish.

Fig. 5 shows a bit of the *Skin of a Lump-fish, cyclopterus,* magnified. When a good specimen is procured, it forms a most beautiful object.

SECTION OF AN ASH BRANCH.

Fig. 5. *Section of an ash-branch.* The power of the microscope is evinced, by comparing the natural size and indistinct forms of this object, with the beautiful results of the microscopic object in large. Nothing can be better calculated to display the wonderful economy of vegetation, and the surprising variety of tubes and mechanism, essential to the growth and support of a tree or plant.

The exterior circle represents the cuticle, or epidermis, which serves to protect the delicate vessels of the cellular membrane within, and also to transmit exhalations. Beneath this cuticle lies the cellular integument, and the bark or cortex lies below the cellular integument, varying the number of its layers, according to the years of the plants. Next to the bark comes the wood, which consists of concentric layers, which are hardest near the pith; its tenacity arising from the innumerable vessels which pass from one part to another in an horizontal direction, and a cellular substance binds the whole together.

In the middle is the pith, or medulla, a light, spongy, and soft substance, composed of tubes in the manner represented.

The entire substance, from the pith to the cuticle, is composed of cells and tubes, which form a continued series of central and alburnous vessels, terminating in the leaf; and from the leaf, a series of cortical vessels return through the bark.

The Bug.

Fig. 1 represents the most ornamented of the bug genus, of which Linnæus enumerates 121 species; but that most known in England, and the pest of our bed-furniture, is called the *house-bug*, and its thirst for human blood is but too well-known in most large cities. The species represented is the *Cimex striates*, or *elm-bug;* on which tree it is found in June; and its natural size is represented at (*a*). The larvæ of bugs differ only from the perfect insect by their want of wings, and they change to *chrysalis* without undergoing any material difference, except having their wings unfolded. The larvæ are very voracious, and spare nothing they can overcome; but, in their perfect state, they glut themselves with blood, and destroy caterpillars and small flies. The house-bug, or *cimex lectularius*, is, however, in his turn, devoured by spiders, and by those of his own genus known by the name of wood-bugs.

Asparagus Insect.

Fig. 2 shows the *Chrysomela asparagi*, or asparagus insect. Of this genus Linnæus enumerates 122 species, distinguished by their colours. They abound in woods and gardens, and the species represented is found on asparagus after it has run to seed. They are slow in motion, and emit a disagreeable oily liquor. They feed on leaves. Another species is the *turnip-fly*, which infests turnips and other tender leaves of plants, of which they destroy whole fields and beds. The natural size is represented at (*b*).

The Meloe, or Cantharides.

Fig. 3. This insect is famous under the name of Cantharides, and used for blistering-plasters in medical practice. The most powerful are those which come from Spain. They are so acrimonious and corosive, that persons who pick them up without gloves have been dangerously affected in the urinary passages. Applied to the skin as a plaster they excoriate the part, raise a blister, and occasion a copious discharge of serum. If taken inwardly, they create dangerous and violent inflammations of the intestines. The natural size is at (*c*).

Wing of the Hemerobius Perla

Fig. 4 represents the wing, magnified, of the *Hemerobius perla*, an insect which seldom lives above three days. The wings are nearly of a length, and exactly similar, composed of delicate nerves, regularly and elegantly disposed, beautifully adorned with hairs, and lightly tinged with green. The body is of a fine green colour, the eyes appear like two burnished beads of gold, hence it is named *golden eye*. This insect lays its eggs on the leaves of the plum or the rose tree, of a white colour, and each fixed to a little foot-stalk, by which they stand off from the leaf, resembling the fructification of some mosses. The larva from these eggs resembles that of the coccinella or lady cow, but is more beautiful. Like that, it feeds on aphides, or pucerons; sucks their blood, and, forming itself a case with their dried bodies, it changes into the pupa state, whence it emerges in the form of a fly.

SHELLS.

Nature is nowhere more lavish in the display of regular forms of beauty than in the construction and colouring of shells.

It cannot be supposed that such alternations of colours, stripes, and varied figures, are results of chance; nor that they have been introduced without some design and some use. It would indeed appear, from human conceptions of such things, that the creatures who inhabit them must have perceptions of beauty, and that these displays are calculated to excite in them feelings of mutual affection, and, perhaps, of pride, necessary to the conservation of their species. The specimens given in the plate are intended to represent some of the chief varieties; but those who seek to gratify themselves still further in this branch of natural history may consult the elegant work of Mr. Mawe, or any other of the books which are specially devoted to the study of conchology.

According to the Linnean system, Testaceous Animals are divided into three classes: multivalves, with more than one piece, or valve; bivalves, with two valves, or pieces; and univalves, composed of one valve, or piece. The animal inhabiting shells, is a soft, fleshy, bloodless substance, without bones, but generally furnished exteriorly with a muscle, by which it adheres to the shell, occasioning certain indentations, thence called muscular impressions. Like other animals, it is endued with lungs, heart, mouth, and organs, peculiarly adapted to its nature. The inhabitants of multivalves and bivalves are viviparous; but, of univalves, some are oviparous. They may be considered as one of the sports of nature; the shell, which is exterior to the animal, being equivalent to the bones of most other animals, so that here are the same parts, though arranged in a totally different manner; the bones, in general, conferring strength in the interior of the animal; whereas, in testaceous creatures, the bony matter serves for strength and shelter. They are a class of subjects difficult to represent graphically, because their beauty consists in their involutions, and in irregularities, which cannot be well depicted on a plain surface, and the variety of their colouring is much heightened in its effect by the high polish of their surfaces. Of the habits and passions of the animals, of which the shells have been their tenements, little or nothing has been observed. The most brilliant shells are brought from the coasts of Hindoostan

THE SAILING MEDUSA.

The *Sailing Medusa* appears floating on the water like a mere lifeless lump of jelly. It is whitish, with a blue cast, elevated into a convexity in the middle on the upper side, and furnished with a fringe of white or rigid filaments round the edge, resembling white hairs. This species is very frequently seen floating on the surface of the sea, or adhering to rocks; and, when the sun shines on them, they have a beautiful lucid appearance.

THE ARGONAUT, OR PAPER NAUTILUS.

This species of shell-fish is said to be named from a Greek word, which signifies both a ship and a sailor; the shells of all the Nautili having the appearance of a ship with a very high poop. The shell of the Argonaut, when out of water, is no thicker than paper. When it sails it expands two of its arms on high, and between these supports a membrane which serves as a sail, and the two other arms it hangs out of its shell, to serve as oars, and the office of steerage is generally served by the tail. When the sea is calm, numbers of them are seen thus diverting themselves; but, when a storm arises, or they are disturbed, they draw in their legs, take in as much water as makes them specifically heavier than that in which they float, and then sink to the bottom. When they rise again, they void this water by numerous holes, of which their legs are full. The other species of nautilus, whose shell is thick, never quits that habitation. It is easy to conceive that the ingenious practices of this wonderful creature may have suggested to man the power of sailing upon the sea, and of the various apparatus by which that object is effected.

VARIOUS INSECTS.

Scarabæus Carnifex, or Bill-Chaffer.

The above species is common in America; and is so strong, though not much larger than a common black-beetle, that, if one of them be put under a brass candlestick, it will cause it to move backwards and forwards. It appears from April to September. It constructs a proper nidus for its eggs, by forming round pellets of dung, in the middle of each of which it deposits an egg. These, in September, the insects convey to the depth of about three feet into the ground; where they remain till the approach of spring, when the grubs burst their shell, and find their way to the surface of the earth.

The Beetle, or Scarabæus Hercules

Of this genus there are eighty-seven species, all which have hard cases to their wings, which protect them in the earth, where they chiefly live, and which causes a humming noise when they fly. Beetles may be said to resemble shell-fish in their formation, their bones being placed externally, and their muscles within. Some are not larger than a pin; while others, as the Elephant and Hercules Beetle, are as large as a man's fist. The small ones go through the stages of their existence in a single season; while the large ones are four years in progression, and live as winged insects another year. The May-bug, or Door-beetle, or Cock-chaffer, lay their eggs in the ground, where a small grub or maggot is hatched, which continues in that state for three years, devouring the roots of plants: at length they grow to the size of a walnut, or thick white maggot, with a red head. In this form it lives for above three years in the worm-state under ground, blind, voracious, and every year changing the skin. At the end of the fourth year, it works itself much deeper into the earth, and there forms a capacious apartment, with smooth and shining walls. It then shortens itself, bursts its skin, and assumes the form of a chrysalis,—first yellow, and then red; the exterior discovering all the vestiges of the future winged insect. It continues in this state for three months, and in January the aurelia becomes a winged insect, completely formed. It now continues for three months in a sort of infant state, feeble and sickly, bright in colour, and soft in its parts. About the end of May these insects, after having lived four years underground, burst from the earth Such is the preparation and wonderful birth of the May-bug, or cock-chaffer. They flourish during the warm weather, bore holes in the ground, lay about three-score eggs; and, on the approach of winter, those perish who have not previously been destroyed by birds or the wantonness of youth.

Scarabæus Hercules, or Elephant Beetle, is found on the northern coasts of South America, and is from four to five inches long, and two inches and a quarter broad. It is black; and the whole body is covered with a shell as thick as that of a small crab. The horns are nearly an inch, and the proboscis is nearly an inch and a quarter, long. It is the largest of this genus.

The Vegetable Fly.

In some of the West-India islands, there is a fungus of the clavaria kind, that springs from flies, of the origin of which two accounts are published in the 53d volume of the Philosophical Transactions. One of them states that the fly buries itself in May, and in three months a fungus springs from it, three inches high, bearing pods which produce worms, and then turn into flies like the buried parent.—The other asserts that the fly, in the nympha state, merely perishes among dead leaves, and its remains afford a bed from which the seeds of the clavaria shoot and grow. The engraving represents the fungus attached to the fly.

The adjoining fly is the species common in our English fields.

The Praying Mantis.

Fig. 7 and 8. The Praying Mantis, or Soothsayer, is an object of much respect among the superstitious eastern nations, who consider its uplifted fore-legs, when standing upright, as an attitude of forewarning, and hence its name. We have introduced the animal at large, and another in a standing posture and praying attitude.

This extraordinary insect is named from the Eastern notion that it possesses supernatural powers. This idea has originated in the peculiar manner of its holding its fore-legs when sitting, which superstition has construed into an act of prayer; so that the bewildered traveller supposes that he will be guided into the right path, according to which leg the animal first stretches out. The Hottentots hold this animal in such veneration, that they consider themselves blest if it alights on them, and they accordingly pay it a species of adoration. The animal represented is much magnified.

Fulgora, or Lantern Fly.

In the engraving this beautiful insect is represented with its wings closed.

THE EGYPTIAN LOCUST.

These elegant creatures are met with in immense swarms on the banks of the Nile, where they present the most brilliant display of colours in the whole range of nature's curiosities.

THE MIGRATORY, OR WANDERING LOCUST.

Many locusts, when minutely examined, are extremely curious, and very pleasing; but, considered collectively as destroyers of a country, they appear in an awful light. Desolation and famine mark their progress; and, where these destructive insects alight, not a leaf is left upon the trees, a blade of grass in the pasture, nor an ear of corn in the fields. Mr. Forbes saw, in India, a flight of locusts extending above a mile in length, and half as much in breadth: they appeared like a black cloud at a distance; and, as they approached from the east, the density of the cloud obscured the solar ray, and threw a gloom over the country, like that of an eclipse. In short, the annals of most warm countries record devastations produced by locusts. They are bred in the warm parts of Asia and Africa, whence they have often taken flight; and, in 1748, some were seen in England; but, happily, our cold climate was unfavourable to their production, so that, being only animals of a year's continuance, they soon perished.

GREAT LANTERN, OR FIRE FLY.

This nocturnal animal is wonderfully provided with a phosphorescent light in its head, which enables it to seek its prey by night. The light is so strong as to enable a person to read a newspaper by it; while the motions of the wings give the animal the appearance of emitting flashes of light. They abound in various tropical regions, particularly in the woods of Surinam, so rich in every kind of vegetable and animal existence; and they are so numerous on the South-American continent, as to present a peculiar night-feature to newly-arrived Europeans.

COSSUS CATERPILLAR.

To convey a just and accurate notion of the most wonderful economy of the meanest insect, we have selected as a specimen of the whole the development of the internal structure of the small caterpillar which harbours on the willow.

Fig. 1-2 exhibit the anatomy of the cossus caterpillar, which lives on the willow.

The body of this caterpillar consists of twelve rings, marked 1, 2, 3, &c.: each is distinguished from the preceding and following, by a neck or hollow; and the boundaries to the rings make twelve other divisions: to the first the word *ring* is affixed, and to the second *division*

Fig. 1-3 show the muscles, arranged with the most wonderful symmetry and order, especially when taken off by equal strata on both sides, which exhibit astonishing and exact form and correspondence. The figure shows the muscles of two caterpillars opened at the belly, and supposed to be joined at the superior lines. The muscles of the back are marked by apitals; the gastric muscles by Roman letters; the lateral ones by Greek characters; and those marked θ are dividing muscles.

The muscle A in the first ring is double; the anterior one thick at top, and, on the upper side, divided into different muscles, but without any such appearance on the under side. One insertion is at the skin of the neck towards the head; the other a little above; and that of the second muscle, A, a little below the first spiraculum, near which they are fixed to the skin.—The muscle α is long and slender, fixed by its anterior extremity under the gastric muscles *a*, *b*, of the first ring, to the circumflex scale of the base on the lower lip. It communicates with the muscle *c* of the second ring, after passing under some arteries, and itself introduced below the musle θ.—The muscle β is so tender, that it is scarcely possible to open the belly of the caterpillar without breaking it. It is sometimes double, and sometimes triple. Anterior it joins the posterior edge of the side of the parietal scale, the lower fixture being at the middle of the ring near the inferior line.

Three muscles are marked ξ: the first affixed at one extremity near the lower edge, higher up the parietal scale; the other end divides into three or four tails, fixed to the skin, under the muscle δ. The anterior part of the second is fixed near the first; that of the third a little under the first and second, at the skin of the neck under the muscle A; and these, passing over the cavity of the first pair of limbs, are fixed by several tails to the edge opposite this cavity. In this subject two muscles are marked δ, but sometimes only one is anterior, fixed to the lower edge of the parietal scale, the other ends inserted in the first fold of the neck. Fig. 20 best represents the muscles β and δ; as they do not appear injured by any unnatural connexion.

In the second and four following rings, we discern two large dorsal muscles, A and B. In the 7th, 9th, and 10th rings are three, A, B, and C; in the 11th are four, A, B, C, and D; and in the anterior part of the 12th ring are five, A, B, C, D, and E. All these, however, as well as the gastric muscles *a*, *b*, *c*, *d*, appear only as a single muscle, running nearly the whole length; but, when detached, consists of so many distinct muscles, each the length of only one ring, their extremities being fixed to the division of each ring, except the middle muscle, *a*, which, at the 6th, 7th, 8th, and 9th rings, has its insertions rather beyond the division. Each row appears as one, because closely connected at top by some fibres from one ring to the other.

The muscles A, 12 in number, gradually diminish in breadth to the lower part of the last ring; at the 8th and three following divisions, they communicate with the muscles B, and at the 11th with D. The lower part of the last ring, A, is much broader that in the preceding ring; one extremity is contracted, and communicates with B: the lower insertion being at the membrane I, the exterior skin of fæcal bag. The muscles A and B, on the lower part of the last ring, cannot be seen until a large muscle is removed, which on one side is fixed to the subdivision of the ring, and on the other to the fæcal bag.

The right muscles B, also 12 in number, begin at the second ring, and enlarge to the seventh, and are usually narrower to the 12th; the deficiency in width being supplied by the six muscles C, from the 7th to the subdivision of the 12th ring. The muscles B and C communicate laterally with the 8th, 11th, and 12th divisions. C is wanting at the subdivision of the 12th, being supplied by B, which there becomes broader.

The first of the three floating muscles, V, originates at the first ring, thence introduced under N, and then subdivided and hidden under other parts. The second, at the second division, fixed to the anterior extremity B, directing itself towards the stomach, after communicating with the case of the *corpus crassum*, divides, and spreads into eight muscles along the belly. The third, at the third division, originating at the skin, and the junction of the muscles B, directs itself obliquely to the belly near the third spiraculum, and, branching, forms the oblique muscles of some of the viscera.

The thin long muscle θ is single at the subdivision of the last ring, and covers the anterior insertion of the muscle *a*, where the ring terminates. It begins at one extremity of the muscle *c*; at the fore-part of the ring runs along the subdivision round the belly to the extremity of a similar muscle C.

Fig. 2, shows the dorsal muscles of the cossus: to be viewed advantageously, observe the following mode of preparation:

Take out all the 35 dorsal muscles, and the seven lateral ones.

Take away all the straight muscles of the belly, the muscular roots, *c*; and the ends of the gastric muscles, *c*, at the third and fourth divisions; and remove at the second division the muscle θ, leaving only the extremities to show where it was inserted.

Begin at the third ring, where are four dorsal muscles, C, D, E, and F. The first, C, is inserted at the third division, under the muscles θ and *α*, where it communicates by some fibres with the muscle, *f*, of the second ring; proceeds obliquely to the intermediate superior line, and is fixed at the fourth division. When C is retrenched, the muscle D is seen wider from the anterior extremity, in a contrary direction to C, and inserted into the third and fourth divisions. The muscle E lies in the same direction as C, but less obliquely: the lower insertion is at the fourth division; the other at the third immediately under C. The muscle F is nearly parallel to D, which joins it; the first insertion is visible, but the other is under E and G at the fourth division.

In the eight following rings are only two dorsal muscles; and D only is completely seen, very large, and diminishing from one ring to the other to the last, sending off some branches. E is one of the straight muscles of the back, inserted under the dividing muscles θ, at the divisions of its own ring.

On the anterior part of the 12th ring are three dorsal muscles, D, E, and F. D is similar to that of the preceding ring, (marked also D,) only half the length; terminating at the subdivision of its own ring. E is of the same length, and differs only in direction from the muscle E of the preceding ring. F is parallel to E, and shorter, its anterior end not reaching the twelfth division.

The posterior part has only one dorsal muscle, fastened by some short ones to the subdivision of the last ring, traversing the muscle α, as if to strengthen them and vary their direction.—α is a single muscle, the anterior insertion visible, the other fixed to the bottom of the foot of the last leg to move the foot. The anterior part of the muscle β branches across the superior line obliquely, and is fixed to the skin a little above. The other end is fastened to the membrane T.

Fig. 2 and 4 show the muscles when the insect is opened at the back.

The first ring has only two gastric muscles, *c* and *d;* the former is broad, with three or four little tails; the first fixture is at the base of the lower lip, whence it descends obliquely, and is fixed between the inferior and lateral line. The small muscle *d* is fastened on one side to the first spiraculum; on the other, lower to the intermediate inferior and lateral line, and seems an antagonist to the muscle P, which opens the spiracula. The posterior fixture of δ is under the muscle C, near the skin of the neck; β is fixed a little on the other side of C, at the middle of the ring. In the second ring are three gastric muscles, *g*, *h*, and *i;* but only the anterior part of *i* seems fixed at the folds which terminate the ring. The muscle *h* is triple, and, in one division, in two parts; that marked *i* comes nearer the inferior line, fixed beyond the middle of the ring, where the corresponding muscle of the opposite side is forked to receive it. In the third ring, the muscle *h*, triple in the foregoing ring, is double here, that nearest the inferior line being broadest; it has three tails, and is exactly similar to the preceding ring, crossed by the muscle from the opposite side.

Through all the eight following rings, the muscle *f* is very broad and strong. The anterior part is fixed at the intermediate inferior line, on the fold of the first division; the other part is fixed beyond the lower division, but at the 10th and 11th rings and at the last fold; whereas, in the others, it passes over that ring, and is inserted into the skin of the following one. In all, the first extremity of *g* is fastened to the fold which separates the ring from the preceding one, parallel to *f*, and at its side. The six muscles marked *g* are forked; that of the fourth ring more than the rest, and unites only near its anterior insertion. The longest tail holding the following inserted near the inferior line; the other near the same line about the middle of its own ring. These two do not branch out; but terminate at the divisions. The muscle *h*, at the side of *f*, has nearly the same direction, and finishes at the folds of the ring.

The anterior part of the 12th ring has only one gastric muscle marked *e*, placed on the intermediate inferior line; and inserted at the folds of the upper division and subdivision of this ring. The lower part has a larger muscle *e*, with several divisions; one under *b*, with one extremity fixed near the lateral line, at the subdivision of its ring; the other to the fæcal bag, a little lower than the muscle *b*.

In fig. 2, the gastric muscles described in fig. 4 disappear, and those lateral and dorsal ones of which the letters are not found.

In the first ring are the gastric muscles, *e*, *f*, *g*, best seen here: the first is narrow and long, passing under and crossing *f:* one insertion is at the lower line, the other at the lateral, between the spiraculum and neck: *f* is short, broad, and nearly straight, along the intermediate line; but passing between it and the lateral under *e*, and fixed to the fold of the skin which goes from one bag to the other; the lower insertion is near the second division. There are sometimes three or four muscles of *g;* the lower parts fixed about the middle of the ring, and the anterior at the fold of the skin near the neck, with the muscles *i* and *h;* the other end of *h* being fixed under the muscle I, I, near the spiraculum. Above the upper end of *f*, is a muscular body, *g*, formed by the separation of two floating muscles.

The second ring has six gastric muscles, *k*, *l*, *m*, *n*, *o*, *p*. The first is large and oblique, with three or four divisions at the anterior part of the ring; the head is between the inferior and intermediate lines at the fold of the second division, whence, crossing the inferior line and its corresponding muscle, it terminates right and left of the line. I is narrow, the head fixed to the fold of the second division; the tail lying under *n*, and fastened to the edge of the skin that forms the cavity of the leg. The two muscles *m* have the same obliquity, placed one on the other; the head inserted in the skin under β, communicates by fibres with the tail of γ; the other end is fixed to the intermediate inferior line at the fold of the third division. The large and broad muscle *n* covers the extremity of the tail of *l*, and the lower edge of the cavity of the limb: fixed first at the skin, near the intermediate line, from whence it goes perpendicularly towards *m*, and under *o* and *m* it is fixed. The muscle *o* is narrow, bent, and covers the edge of the cavity of the leg a little; one end terminating there, and the other at the third division near *m*. That marked *p*, also bent, runs near the anterior edge of the cavity of the leg; one end meets the head of *o*, the other terminates at a raised fold near the inferior line. There is a triangular muscle on the side of the lateral muscle *o*, similar to that marked *g* in the following ring.

The third ring has no muscle similar to *m;* that marked *k* differs from that of the second ring only in being crossed by the opposite muscle: *l*, *n*, *o*, *p*, are similar to those of the preceding; *q* is triangular, the base fastened to the last fold of the ring; on the lower side it is fixed to *o*, the top to the skin at the edge of the cavity for the leg.

The eight following rings have the gastric muscles, *i*, *k*, *l*, and *m:* *i* is straight, and at some distance from the inferior line, broad at the fourth ring, but diminishes gradually to the 11th. At the fourth it divides into two heads, which divaricate in the following rings. In the six next rings these heads are fixed nearly as *a* and *f;* and the others terminate at the fold of the ring. The anterior insertion of the first and last is at the fold where the ring begins: that of the six others is lower, under where *i* terminates. The lower part of *k* is in the skin near *i;* the upper part at the intermediate inferior muscle upon the fold which separates the following ring, but is wanting in the 11th. The muscle *l* is large, and co-operates with M; in opening and shutting the spiraculum, one fixture is near the intermediate inferior line, at about the same height as *i*. The tail terminates a little below the spiraculum.

The twelfth ring has only *d*, which is a bundle of six or eight muscles; the first fixture is at the subdivision of the ring near the inferior line: one or two cross this, and likewise the similar muscles of the opposite side. Their fixture is at the bottom of the foot, to assist the muscle *a* in bringing back the foot, and to loosen the claw from its hold. One of the insertions is near *d*, the other near the subdivision of the ring.

Fig. 5 and 6 show imperfectly the organization of the head Lyonet employed *twenty* figures to explain it fully, as it appears separated from the fat, and disengaged from the neck. H H are the two palpi. The truncated muscles D belong to the lower lip, and assist in moving it. K shows the two ganglions of the neck united. I I are the two vessels which assist in spinning the silk. L, the œsophagus. M, the two dissolving vessels. The Hebrew characters רכבא show the continuation of the four cephalic arteries. In fig. 5, S, T, V, and Z, the ten abductor muscles of the jaw. Four occipital muscles are seen in fig. 6, under *e e* and *f f; a k* is a nerve of the first pair, belonging to the ganglion of the neck; *b* a branch of it.

Fig. 7 exhibits the nerves seen under: but, except two or three easily distinguished, only one of each pair is drawn. The nerves of the first ganglion of the neck are marked by capital letters; those of the ganglion (a) of the head by Roman letters; the nerves of the small ganglion by Greek characters; those of the frontal ganglion by numbers.

The muscles of the cossus differ in colour and form from those of larger animals. They are soft, of the consistence of jelly; in colour, a greyish blue, which, with the silver-coloured appearance of the pulmonary vessels, form a brilliant spectacle: but, when soaked in spirit of wine, they lose their elasticity and transparency, become firm, opaque, and white, and the air-vessels disappear. This number is very great. The head is almost composed of them, and there is a vast number about the œsophagus, intestines, &c. the skin is lined by different beds placed one under the other with great symmetry. Lyonet distinguishes 228 in the head, 1,647 in the body, and 2,066 in the intestinal tube: in all 4,041.

At first sight, the muscles might be taken for tendons, as having the same colour, and near the same lustre. They are generally flat, and equal throughout, the middle seldom differing from either extremity. When separated by very fine needles, in a drop of some fluid, they seem composed of fibres, membranes, air-vessels, and nerves; and, from oil seen floating on the fluid, they seem furnished also with many unctuous particles. Their ends are fixed to the skin, but the rest is generally free and floating. Several branch out, and sometimes so far, as not to be easy to discover whether they are distinct or separate muscles, or parts of another. They are moderately strong; and soaked in spirit of wine, when examined by the microscope, are covered with a membrane, and appear to consist of several parallel bands longitudinally, which, when divided by fine needles, appear composed of still smaller bundles of fibres in the same direction, and, with a powerful magnifier, twisted like a small cord. The muscular fibres of the spider, much larger than these, consist of two substances, one soft, and the other hard, twisted round the former spirally, and giving it the twisted appearance

Nothing in the caterpillar is similar to the brain in man. There is, indeed, in the head a part from which all the nerves seem to proceed, but it is entirely unprotected, and so small as not to occupy one-fifth part: the surface is smooth. As this is called a brain, the caterpillar has *thirteen*, there being twelve other such parts in a straight line, all of the same substance and size, from which the nerves are distributed through the body. The spinal marrow along the belly is very small, forking at intervals, nearly equal throughout, except at the ganglions, and not inclosed. It is less tender than in man, has great tenacity, and only breaks with considerable tension. Its substance differs from that of the ganglions, as no vessels can be discovered in it, but they are full of very delicate ones. There are 94 principal nerves, having innumerable ramifications.

The cossus has two large beautiful silver-coloured tracheal arteries under the skin close to the spiracula, each side of the insect communicating with the air by nine spiracula. They are almost as long as the whole caterpillar; beginning at the first spiraculum, and extending beyond the last, and some branches to the extremity of the body. Round each spiraculum the trachea pushes many branches, again divided, and these further subdivide through the whole body. The tracheal artery, with its ramifications, are open elastic vessels, which may be pressed close, or drawn out, but return immediately to their usual size when the tension ceases. This artery, and its principal branches have three coats; the outmost is thick, with various fibres, which describe numerous circles round it, communicating by many shoots. The second is thin and transparent, without any particular vessel distinguishable. The third is scaly threads, of a spiral form; and so near as scarcely to leave any interval. They are curiously united with the membrane which occupies the intervals, and form a tube, always open, notwithstanding the flexure of the vessel. Its structure has many other peculiarities. The principal tracheal vessels divide into 1326 branches.

The heart differs from that of other animals, being almost as long as the animal itself. It lies immediately under the skin of the back, entering the head, and terminating near the mouth.

Near the last rings of the body it is large and capacious, diminishing much from the fourth to the twelfth, as it approaches the head. On both sides an appendage partly covers the muscles of the back, but, growing narrower as it approaches the lateral line, it forms irregular lozenge-shaped bodies. This tube, however, performs none of the functions of the heart in larger animals, as no vessel opening into it answers either to the aorta or vena cava. It is called the heart, because generally filled with lymph, which naturalists suppose to be the blood; and because, in all caterpillars with a transparent skin, are seen alternate regular contractions and dilatations along the superior line, but begin at the eleventh ring, and proceed from ring to ring, to the fourth; hence this vessel is supposed to be a string or row of hearts. Two white oblong bodies join the heart near the eighth division, and are called *reniform* bodies, from their resemblance to a kidney.

The most considerable part of the whole caterpillar is the corpus crassum, the first and only substance seen on opening it. Like a sheath, it envelopes all the entrails, and, introduced in the head, enters all the muscles, filling the greatest part of the empty spaces. It much resembles the configuration of the human brain, and is of a milk-white colour.

The œsophagus descends from the bottom of the mouth to about the fourth division. The fore-part in the head is fleshy, narrow, and fixed to its crustaceous parts; the lower part passes into the body, is wider, and has a membranaceous bag covered with small muscles; near the stomach it is narrower, and confined by a strong nerve at distant intervals. The ventricle begins where the œsophagus ends, a little above the fourth division, and finishes at the tenth: it is about seven times as long as broad; and the anterior part, which is broadest, is in folds, which diminish with the bulk on approaching the intestines; the surface is covered with aërial vessels, and opens into the large intestine, one of three large tubes, each so different from the others as to require a particular name.

The two vessels from which the cossus spins its silk are often above three inches long. The body is divided into the anterior, intermediate, and posterior parts. It has likewise two other vessels, supposed to prepare and contain the liquor for dissolving the wood on which it feeds.

ATLAS MOTH.

We present this as a specimen of the gigantic size and exquisitely beautiful colouring of the largest species of moth. Of this genus Linnæus enumerates 1464 species; and the Atlas found in the East and West Indies is the largest. They fly chiefly by night, or towards evening. The chief part of them have no mouths, and pass through his state without food. It is their caterpillars which destroy cloth and furs. They remain in the chrysalis state much longer than butterflies, sometimes for years. The female of some species are without wings. The atlas is so large as to resemble a bird more than an insect; while the richness of their colouring equals that of the feathered race. The antipathy of moths to light is such, that they rush into candles, and in hot climates extinguish them, if the candle is not protected.—The *Peacock Moth* is a native of many parts of Europe, and measures six inches; and there is a smaller sort, a native of England, called the *Emperor Moth.* Its caterpillar, which is very beautiful, feeds on apples, pears, and other fruit. It is the caterpillar of the *Cloth Moth*, so called, which is so mischievous: it changes into a chrysalis in April, and the moth appears in May and June.

THE SILK-WORM, OR PHALÆNA MORI.

By the labours of this humble creature, the pride of man is more fostered than by any other animal. The moth lays its eggs, represented by the small dots near the moth: these, on the approach of warm weather, and in the sun's rays, are hatched into small caterpillars, which grow and feed on mulberry-leaves for a few weeks. When in a suitable situation, they enclose themselves in a cone of silk, where they turn into a chrysalis, represented in the plate; and from the chrysalis emerges a lively white moth, which, having laid its eggs, dies in a few days: the silk is wound off the cone, and furnishes materials for costly garments.

The bags or cones of silk generated by the worms weigh from three to four grains each, so that 2,300 worms produce a pound of silk. What an immensity of labour, therefore, is exerted to produce a few yards of ribbon or a silk gown!

TERMES ANT-HILLS AND PYRAMIDS.

These ant-hills, in the forests of Sweden, are truly wonderful. They consist of cones formed by the leaves and fibres of pine, some of them built even to the height of five feet.

As all countries abound in ants, and each of their hills, or nests, contain many thousands, they are, perhaps, the most numerous creatures in existence, and doubtless exceed the human race millions and millions of times; generally, and especially in the British Islands, they are so perfectly harmless, that their ingenuity entitles them to the respect and friendship, as well as the admiration, of man.

TERMES, OR WHITE ANTS.

There are eight species of these insects the most remarkable of which is the *fatale*, or bellicosus, which is of a yellow colour above, and the wings also yellowish. Their works surpass those of bees, wasps, beavers, and other animals, as much as works of the most polished European nations excel those of the least cultivated tribes. Even the boasted pyramids of Egypt fall comparatively short, in size alone, of the structures raised by these insects; and, in the interior construction and the disposition of the building, they appear greatly to exceed that of any like work of human construction.

These ingenious insects are divided into three distinct ranks and orders, constituting a well-regulated community. These are, first, the labourers, or working insects; next, the soldiers, or fighting order; and lastly, the winged, or perfect insects, which may be called the nobility or gentry of the state. These are only capable of being elected kings or queens; and they emigrate within a few weeks after they are elevated to this state, and either establish new kingdoms, or perish within a day or two. In the engraving are represented the several orders:

Fig. 1 represents a labourer.
—— 2, a labourer magnified.
—— 3, a soldier.
—— 4, a soldier's forceps and part of his head magnified.
—— 5, a perfect termes bellicosus.
—— 6, the head of a perfect insect, magnified.
—— 7, a head, with a stemata magnified.
—— 8 and 9, a queen and king.

WHITE ANT-HILLS.

The hills of the white ants are most wonderful structures. They are composed of an exterior and interior part. There is a royal chamber situated near the centre of the building; the entrances to which admit only the labourers or soldiers. The chamber is surrounded by several others, all of them being arched either in a circular or elliptical form. The latter apartments are joined by magazines and nurseries. The magazines are stored with provisions, which, when examined by the microscope, are found to consist of gums or dried juices of plants. The nurseries are occupied by the eggs and the young ones.

This powerful community, considering the world as made for them, commit great devastations, and construct roads, or rather covered ways, in all directions from the nest, to every object of use within reach. The ravages they commit, though great, are probably counterbalanced to other animals by the good produced, in quickly destroying dead trees and other substances, which would, by a tedious decay, encumber the ground.

If any one wantonly makes a breach in any part of the structure, a soldier immediately appears, and walks about the breach, to see whether the enemy is gone, or to examine whence the attack proceeds. He is quickly followed by two or three others; and then a numerous body rush out as fast as the breach will permit, their numbers increasing while any thing continues to batter the building. During this time, they seem in the most violent bustle and agitation; some beating with their forceps upon the building, making a noise that may be heard three or four feet distant. On ceasing to disturb them, the soldiers retire, and are succeeded by labourers, who hasten in various directions towards the breach, each with a burden of ready-tempered mortar in his mouth. Though there are millions, they never embarrass each other; and a wall is raised to fill up the chasm. A soldier attends every 600 or 1000 labourers, seemingly as director of the work; for he never touches the mortar, either to lift or carry it. One, in particular, places himself close to the wall they are repairing, and frequently makes the noise above mentioned; which is constantly answered by a loud hiss from all the labourers within the dome; and, at every such signal, they evidently redouble their exertions. As a renewal of the attack constantly produces the same effects, the pleasure of seeing them come out to fight, or to work, alternately, may be obtained as often as unfeeling curiosity excites. The devotion of the soldiers is remarkable: they fight to the very last, disputing every inch of ground so well, as often to drive away the negroes, who are without shoes, and make white people bleed plentifully through their stockings.

It is indeed dangerous to approach these hills without suitable precautions, as the courage and patriotism of the ants render them indifferent to danger, and they inflict severe wounds.

FASCIATA, OR BARBARY SPIDER.

This frightful-looking animal inhabits hedges and thickets, where it spreads its snares for wasps, drones, and even locusts. The animal which it entangles is soon killed by the spider, and, if only partly eaten, the rest is concealed under some dry leaves, covered with a web and blackish glue. Its larder is plentifully stored. Its nest is about the size of a pullet's egg, divided horizontally, and suspended by the threads of the insect. It carries its eggs in a bag under its belly, from which the young ones come out, and for a time, in the same web, live in amity; but, when grown up, are mortal enemies. They never meet but they fight; and the battle generally ends with the death of one.

The engraving exhibits the Barbary spider in his web, at the moment of seizing his prey.

GREAT SCOLOPENDRA, OR CENTIPEDE.

This specimen possesses but forty-two legs, but some of the tribe have not less than 148 on each side. The species called *Wood-louse* has but fourteen. In hot climates the centipedes are from six to nine inches long; and they are common in England, though seldom above an inch long, and with 20 or 30 legs. Their bite produces inflammation, and in Jamaica is considered dangerous.

THE WHALE.

The whale, as found in the Polar Seas, is ninety feet in length, and twenty in breadth: but, in the seas of the Torrid Zone, many are seen a hundred and sixty feet long. The head is much disproportioned to the size of the body, being one-third the size of the fish; the eyes are remarkably small; and the under lip is much broader than the upper. The tongue is from eighteen to twenty feet long, and the gullet is only four inches in width. The tail is of an amazing size, and semilunar shape; and the animal employs it very effectively in accelerating its enormous body, which, though so bulky, passes through the water with great rapidity, and leaves a track like that made by a large ship.

This fish varies in colour; the black of some being red, the belly generally white; others are black; some mottled; and others are quite white. They are gregarious, and feed on vegetables, and are perfectly harmless, unless attacked or wounded. There is a double pipe to the head, through which the whale spouts water to a great height. The females suckle their young, and their breasts contain a large quantity of milk. They are very affectionate, and have no enemies but man, the universal and unmerciful tyrant of the animal creation.

CAPTURE OF A WHALE.

This engraving conveys a correct idea of the scenery and practices of the Greenland seas. An unfortunate whale having been harpooned, and having bled to death in the water, is here represented, after being dragged on the shore; when the crew of the Greenland-man employ themselves in cutting up the body and extracting the blubber, with which nature had provided this warm-blooded fish, as a defence against the cold, because oil is a slow conductor of heat. The enormous proportions of the animal, compared with man, is rendered evident by this mode of display, while the powers of the human intellect, in enabling such small animals to overcome so large a one in his own element, must strike every observer.

GYMNOTUS, OR ELECTRICAL EEL.

This animal possesses the extraordinary power of communicating an effect, on being touched, like that which is experienced on receiving a spark of electricity, or touching the prime conductor of a machine. It also affects the water in which it swims, so that, if one hand touches the animal, and the other is put in the water, a shock is felt like that from a Leyden phial; and several persons, joining hands, feel the same effect. The sensation is also felt when it is touched by conductors, as in electricity, and interrupted by non-conductors. On dissecting it, it is found that the whole of the space which is included within dots from the head to the tail, consists of a series of separated muscular plates, not unlike those in a galvanic combination, but very close together; and thus a strong natural electricity is accumulated, by a process somewhat similar to that in the galvanic series. This is a most wonderful structure; and a similar effect is experienced in the torpedo, the silverus electricus, and some other fish, although the structure of their electrical organs is somewhat different.

SCORPŒNA.

Head covered with spines or protuberances, destitute of small scales; one dorsal fin.

There are sixteen species of this genus. They have all a very uncouth appearance, and are armed with formidable spines. The subject of the plate is remarkable for two long tentacula, surrounded by several fibrous brown bars, seated immediately above the eyes. It is a native of Amboyna.

ANGEL FISH.

Body depressed; snout rounded; mouth terminal.

This genus contains only one species, the *squalus squatina* of Linnæus.

This is the *mermaid-fish* of Artedi, which, according to some naturalists, has given rise to those stories which we read and hear concerning mermaids.

CHÆTODON.

One dorsal fin; gill-lid destitute of processes; teeth small, flexible, and moveable; opening of the mouth small.

There are forty-two species of this genus. The one which we exhibit is a native of the fresh waters of India. Dr. G. Shaw, after informing us that its prey consists of the smaller kinds of insects, says, " When it observes one of these, either hovering over the water or seated on some aquatic plant, it shoots against it, from its tubular snout, a drop of water, with so sure an aim as generally to lay it dead, or at least stupified, on the surface. In shooting at a sitting insect, it is commonly observed to approach within the distance of from six to four feet before it explodes the water. When kept in a state of confinement in a large vessel of water, it is said to afford high entertainment by its dexterity in this exercise; since, if a fly, or other insect, be fastened to the edge of the vessel, the fish immediately perceives it, and continues to shoot at it with such admirable skill as very rarely to miss the mark.''

HAMMER-HEADED SHARK.

This voracious animal has a remarkable obtuse head, with eyes fixed at its extremities, and its mouth in the centre, as exhibited in the plate. It grows to the length of six feet, and is chiefly found in the Mediterranean.

FROGS AND TOADS.

These belong to the genus Rana, of which there are seventeen species. Frogs appear first in the tadpole state; as soon as they are released from which, they leave the water, and cover the adjoining grass in multitudes. They live chiefly on insects and snails, and give no other offence to man than by their croaking, with which they fill the air in the neighbourhood of their ponds; but during one month their croaking entirely ceases. Both frogs and toads are torpid during the winter. The first figure represents the Pennsylvanian frog, variously coloured, which makes a roaring as loud as a bull, and hence is called the Bull-frog. They spring three yards at a leap, and equal a horse in speed. When in companies, their noise is deafening; and they make it in concert, apparently by mutual signal; and, if beaten, they cry out like children.

Toads, of the species Buffo, are much abhorred for their ugliness, though it has remarkably fine eyes, and is perfectly harmless, and in no degree poisonous, as the vulgar and credulous believe: so far from this, they are the common food of many birds, and of ducks and snakes. Their only offence is their not being handsome, according to human notions of beauty. They live an incredible time, a century or more; and it is no fable that they have been turned alive out of stones, in which they must have been inclosed some thousand years. Yet, with these providential endowments, a poor toad is never found by unthinking urchins without being exultingly stoned to death.

LIZARDS AND OTHER REPTILES.

This plate exhibits several varieties of chameleons, geckos, crocodiles, ignanas, turtles, and tortoises.

The Crocodile. Most of this species are inhabitants of the warmer climates; and are, in general, very active and voracious in pursuit of their prey. The back and belly are covered with large plates, and the head is broad and flat. All the species are capable of living both in water and on land; they generally inhabit the former, but move with ease upon the latter. The rivers of Guinea are infested with vast shoals of these animals; and on hot days great numbers may be seen basking on the banks. In the river Senegal, sometimes more than two hundred of them have been swimming in shoals, with their heads floating above the water, resembling a great number of trunks of trees floating down the river. One of them, taken at Siam, was eighteen feet and a half long, of which the tail was five feet and a half, and the head and neck two feet and a half; and he was eighteen inches in diameter. His hind legs were two feet two inches, and the paws nine inches; the fore-legs are like the arms of a man. Some of them measure twenty-five feet. The crocodile is a voracious and destructive animal, often seizing women who go to the Nile for water, and children playing on the shore. They frequently bask in the sun on the banks, and are fatally mistaken for trunks of trees. They will even enter cottages, and seize on the first animal they meet with; and will drag a man from his canoe Dogs, bulls, tygers, and the human species, are his prey which it seizes with a spring, and drags into the water with his teeth and claws. Its rapidity on shore in pursuing its prey is also frightful. Tygers maintain a desperate conflict with them, but, being dragged into the water, are overcome. Nevertheless, negroes venture to attack them even in the water, with a knife in their right hand, and their left arm wrapped in a towel, which they thrust into his mouth, while they stab him with the knife.

The Crocodile of the Nile has six large carinated plates on the neck. Except when pressed by hunger, or urged by the necessity of depositing its eggs, it seldom leaves the water. In the neighbourhood of Thebes, in Egypt, M. Sonnini's boat was often surrounded by these animals, on a level with the surface; but they allowed the boat to pass with apparent indifference.

There is also a false-bellied crocodile, which receives its young into a paunch for protection, like the opossum

The Alligator is another species of crocodile, represented in the upper figure, with the tail serrated, and the skin covered with tubercles. It is seventeen or eighteen feet long. They abound in the rivers of Carolina, where they float like logs of wood, seizing dogs, hogs, and fish: they are torpid during the winter in dens, which they burrow under ground. The carrion vulture is their deadly foe in South America.

The Cayman of the Antilles is another animal of the same form and species.

Lizards. Many of this species inhabit woody situations, and seek their food in underwood. Others live about ruinous buildings, and feed on insects, fruits, and vegetables. A few are also found in ponds and marshes, where they prey on the smaller animals which inhabit them. Most of them are natives of the warmer climates, but more of this tribe than any other of the genus Lacerta are indigenous in the temperate countries of Europe.

The green Lizard is of a bright colour, marked with numerous black or brown figures, and a verticillated tail covered with scales.

The spotted Lizard is blackish blue above, with a few round spots of a pale violet, and the belly is whitish.

The dark-brown Lizard, with a long tail, is entirely covered with scales. They are common in England, and live upon insects; and are timid and perfectly harmless creatures, though very disgusting to look at, and therefore suffer great persecutions from boys and vulgar men.

The dwarf, common, and *cloven-footed Chameleon.* These animals are natives of India, Africa, and parts of South America. From the earliest periods, this extraordinary reptile has been metaphorically employed to denote fickleness and versatility, on account of its peculiar property of changing colour. It is susceptible of many shades, particularly three very distinct ones, Saxon green, deep green, and a blue and yellow green. When provoked in the open air, and well fed, it becomes blue green; but, when feeble or deprived of free air, the prevailing tint is yellow green. Attempts have been made to account for these changes, by the remark that the blood of the animal is of a violet blue, while the natural colour of the skin is yellow: hence, when the skin is most transparent, and the animal in greatest vigour, the shade of green is darkest, or assumes most of the blue tinge; while, when the skin is least stretched, and the circulation languid, the colour becomes paler, and verges towards yellow white, or even brown. Chameleons are generally of a diminutive size, the largest not exceeding two feet from the muzzle to the tip of the tail, of which the tail occupies one half. It is also remarkable of them, that they are able to look two ways, and able to move one eye at a time. They live chiefly on trees, and their food is insects, which they eat with their tongues; and they are capable of undergoing very long abstinence.

Geckos. These animals are found in South America, in Africa, and the East Indies. They live about walls and in trees, feed chiefly on insects, and have so little dread of mankind, as familiarly to enter their houses. The body is covered with very small prominent scales; the tail is generally cylindrical, but in a few species flattened, as in the flat-headed gecko; the feet have each five broad toes, covered with small scales, concealing glandular pores, from which exudes a very corrosive fluid. They are ranked by some naturalists amongst salamanders, whom many people weakly suppose can live in fire; for which vulgar opinion there is no foundation.

The flat-headed Gecko has the head, body, and legs, flattened at the sides, and bordered with a membraneous fringe. The tail is broad and compressed, with a simple membrane on each side. The *striped or Surinam Gecko* has a tail as long as the body, with brown bands; a yellowish band, bordered with brown, running from the eyes to the thighs. The *banded Gecko* is of a reddish colour, with the body and tail marked with dark bands.

Ignanas. These animals are found chiefly in Africa and the Bahama Islands, and inhabit the woods, sporting among the trees. The tail is surrounded with numerous small rings of minute scales: a high crest of pointed scales extends from the neck to the tip of the tail; and the feet are very strong, each having five toes ending in claws. It is said that the negroes are very expert in catching this animal, amusing it by whistling, and, when it suffers them to approach, tickling it with the end of a rod, they secure it by a cord with a running noose. In the plate are represented five beautiful varieties of this tribe. One of the nations on the coast of Africa consider them as *fetiches*, or guardian genii, and they cherish them in every possible manner. In the Bahamas they are called Guianas, and serve as food to the natives.

The common or green Turtle. The body of this animal is enclosed within a shelly covering, consisting of two parts, one covering the back, and usually called the shield; the other supplying the place of a sternum, and called the breast-plate. The legs are very short, but so strong, that one of the larger turtles has been known to walk with apparent ease, while several men stood on his back. The plates of the shield are thirty-four in number, and the fore feet are furnished with two nails. In their motions these animals are slow and awkward; and, with few exceptions, they are inoffensive, and submit without resistance to the most cruel treatment. Some species have the power of withdrawing their limbs within the shell, where they lie encased, safe from the attacks of almost every animal but man. A gigantic species, with long legs, is found in the Galipagos, some of which weigh five hundred pounds.

Tortoises. These animals have all the toes furnished with claws, but not distinct in all species. The shell is generally hard and horny. They feed on vegetables, insects, worms, &c.; some of them reside on the borders of lakes and rivers, and others live entirely on land.

The Mud Tortoise inhabits the lakes and muddy rivers in the south of Europe. It is very plentiful in France, especially in Languedoc and Provence. Its whole length, from the snout to the tip of the tail, seldom exceeds eight inches, and about three or four in breadth. The young, when first hatched, are not an inch in diameter. They continue to grow for a long time, and are known to live for at least twenty-four years.

The Rough Tortoise has the upper part of the shield yellowish, and irregularly spotted. The marginal plates are twenty-five, the feet are palmated, and one hind toe is without a claw.

The Figured or Manuscript Tortoise has the plates marked above with characters, and spotted on the lower part.

The Yellow Tortoise is variegated with spots, but in its habits chiefly resembles the other species of the tortoise tribe.

The Land Tortoise, known in England, is torpid during the winter, and sleeps much even in summer. They are docile, and even affectionate to those who feed them. It is a fact well ascertained, that one of them lived in the precincts of the cathedral of Peterborough from the reign of James I. to that of George IV., or about 200 years.

THE FLYING DRAGON, OR DRACO-VOLANS.

This harmless creature, with a body four inches long, and a tail of six, has been magnified by poetry and superstition into a tremendous monster. Its colour is an elegant pale blue or bluish grey, and its wings are very elegantly spotted. It inhabits woods in warm climates, where it is seen flying from tree to tree, feeding on various insects. It has four legs, like the lizard; and is about ten inches long.

NATURE DISPLAYED,

IN

A SERIES

OF

POPULAR LECTURES.

LECTURE XXXI.

ANIMALIA.

See thro' this air, this ocean, and this earth,
All matter, quick, and bursting into birth;
Above, how high, progressive life may go!
Around, how wide; how deep extend below!
Vast chain of being! which from God began;
Nature's scarce sentient, up to perfect man,—
Beast, bird, fish, insect; what no eye can see,
No glass can reach. From infinite to thee,
From thee to nothing.

WHAT exquisite pleasure to the intelligent mind is afforded by contemplating the continually renewed succession of the works of Deity! All the effect of that Will, which first spake into existence the magnificent whole, is constantly evinced in the preservation of each species. The real state of every object illustrates the inconceivable omnipotence of the God of Nature. The whole system of Nature is a vast museum, and the properties of its several objects invite investigation. Throughout the whole of organic and animate existence, each subordinate species of being performs its peculiar functions contentedly in the path assigned it. But man, the vicegerent of his Creator, is capacitated for complex inquiries, while contemplating the several objects around him. He surveys, examines, admires; he does not remain satisfied with bare inspection of facts; he carefully distinguishes the effects; and, with a pious confidence, enquires what is the cause. All that we see so admirable in the animal kingdom, demonstrates the existence of a superior Being, who is all-powerful and infinitely wise. What, except Omnipotence, could have peopled this vasty globe with so many and such varied living creatures; or provided them with all that is necessary to their life and well being? Who else could supply all the wants of this innumerable crowd of animals, give them so much sagacity and instinct, assign to each its peculiar element, form all the limbs, joints, bones, muscles, nerves, and vessels; unite them with such perfect harmony, that each can perform its different motions in the manner best adapted to its peculiar modes of existence, and the circumstances wherein it is placed. In enquiring into the scheme of existence, as far as our intellects can comprehend it; in admiring the varied arrangement, and accurate execution of every part, all our ability of measurement and calculation is lost in the innumerable and incomprehensible diversities. The more elevated, expanded, and profound our researches in animated nature, the more beautiful and enlivening is our prospect. The individuals, indeed, do not continue long indestructible, like the sun and planets, of which they are subordinate parts; but the species seem designed to be as durable. In the productions of the year, the decayed and perished herbs, flowers, and fruits, are ever succeeded by new individuals; which is certainly a repetition of the creative and governing power of the Deity. So likewise is it with the races of animals. What an amazing structure of parts, fitted to strain the particles imbibed, and admit and percolate atoms so different in form and size Of the same common earth, how varied and innumerable the beings formed; each differing in taste, colour, smell, and every other property! How wonderfully potent that art, which varies the different animals in their flesh, in all its sensible qualities, though formed by the separation of parts of the same common food! In all this, the Creator's power is present and active; clothing the fields with verdure, elevating the trees of the forest, and congregating the lowing herds and bleating flocks; guiding the pluvial and aerial inhabitants, the minutest insect, and the noxious reptile. He forms their bodies, incomparable in their kind, and endows every object with instincts most astonishing and indescribable.

Organic bodies exhibit characteristics so wholly different from those of inorganic bodies, that they seem to constitute a new creation, obviously different from the old. Without them, the grand fabric would have been incomplete; the immense masses would have exhibited no other result, than silent motion in space, shedding and reflecting their rays on a desert globe, to which activity and quiescence, light and darkness, would have been equally useless.

It is with the distribution of organic objects, as with all the other phenomena of the physical world. Amidst apparent confusion, from the influence of multiplied local causes, we discover the immutable laws of Nature, when surveying an extensive tract of country, or employing a mass of facts agreeing with the partial disturbances. Persons who delight to contemplate the mutual concatenation of organized beings, who are aware that the numerical results, while surveying each class, correct themselves by the accumulation and careful investigation of particular facts, will cherish that kind of research, which elucidates the economy of Nature, the obvious connexion between climates and forms of beings, and the distribution of plants and animals in the different regions of our planet. In the progress of all physical sciences, general ideas, at first deduced only from a small number of facts, compel observers to multiply the partial results.

It has been supposed, that the number and variety of animated creatures, exceeded those of vegetable creation. But, at present, such conclusion is obviously either premature or incorrect; as the immense collections in the Museum of National History, at Paris, contain 56,000 species of plants, flowering and cryptogamous; and 44,000 insects, 2500 fishes, 700 reptiles, 4000 birds, and 500 mammalia. And, of this number, there belong to Europe, 400 birds, 30 reptiles, and

80 mammalia. How extended and beautiful, then, is the scheme of organic nature, of animate creation!!

In the formation, too, of animal bodies, what exquisite mechanism must have formed and arranged the parts! How incomprehensible the motive power which could communicate to such soft and yielding materials, the numerous and varied motions ever going on in the several parts of the system,—the heart, stomach, lungs, intestines; and to the renovation of those motions which are interrupted and restored alternately, as walking, working, or speaking. In the reciprocal action of soft bodies, motion constantly diminishes; and how much then, and how continual, must that diminution be in the yielding softness of the flesh and fluids of animal bodies? Motion is easily communicated or continued in space, especially if the moving body be hard and firm; but it is quite otherwise in the veins, arteries, intestines, and lacteal vessels of the bodies of animals; in the very narrow twining meanders which convey the fluids to the several parts. The capacity of these slender tubes will not admit the finest hair; and their mazes and windings are to us inexplicably perplexed. What a quantity of attrition must there be, while the blood, lymph, and chyle, creep through these not even microscopic vessels! This quantity has never yet been calculated; neither has a term of art been assigned for power, which urges the fluids in animal bodies ten thousand different ways at once; upwards, in opposition to the nature of the force called *gravity;* and continued, as if to mock the fable of *attraction*, which ever stops motion between the particles of liquids.

Man cannot draw aside the veil of Nature. The efforts of all the philosophers who have ever existed, have been insufficient to penetrate into the inscrutable arcanum. Enlightened minds have, indeed, approached near where the secrets of animation commence; but there they have encountered obstacles unsurmountable by any ingenuity yet exerted. Nature is a volume ever unrolled, but some of its characters remain undeciphered; and the legible parts are not always to be read without study, nor to be understood without nice discrimination. Still, however, the intellect of an organized being may reason safely on the mechanical relations of masses, especially the inorganic, because an unequal balance of forces produces their motions, and, from combined motions, result the phenomena.

The stimulus of animal life is every where present in the momenta of the component atoms of gas. The fixation of these, by the economy of the lungs, and the diffusion of this imparted energy to the circulating system, constitute that *principle of animal life*, whose development has puzzled the philosophers of all ages and countries. The motion of the atoms of gas, is that universally extended activity, which creates exhalations from fluids and solids, and then converts those exhalations into crude, and not unfrequently into simple organic forms. But, in regard to the origin of complex organization of forms, which are capable of appropriating gas, and of which gas is but the patient, and of sexual distinctions, separate yet adapted to a common end; it seems difficult to explain the origin and succession, without admitting supernatural agency. "I behold vegetables," (says the author of a Morning's Walk to Kew), "with roots fixed in the ground, thereby raising fluids mechanically; but my understanding is overpowered with unsatisfied wonder, when I consider the animating principle of the meanest vegetable, which constitutes a selfish individual, and enables it, by peculiar secretions, to give new qualities to those fluids, and appropriate them to its own nourishment and growth. My ambition after wisdom is humbled in the dust, whenever I inquire how the first germ of every species came into existence; whenever I consider the details of the varied powers in the energizing agency which originates each successive germ; and the independent but coincident passive receptacle which nurtures those germs, and, correcting aberrations, secures the continuity of every species, both acting as joint secondary causes; and likewise whenever I reflect on the growth, maturity, beauty, and variety, of the vegetable kingdom. On these subjects, my mind renders the profoundest homage to the MYSTERIOUS POWER which created, and continues such miracles; and, being unable to reason upon them from the analogy of other experience, I am compelled to refer such sublime results to agency not mechanical; or, if in any point of meaning mechanical, so arranged and so moved, as far to exceed the means and limits of my conceptions."

"Looking again on the volume of Nature before me," (says the same writer,) "I behold a superior class of organized beings, each individual constituting an independent microcosm, qualified to move from place to place, by bodily adaptation, and nervous sensibility. This assemblage of *locomotive beings*, ascends in gradations of power and intellect, from the hydatic, just capable of exertion, to the sympathetic and benevolent philosopher, desiring and swiftly moving to benefit all around him; and rises in the scale of existence as much above the organization of vegetables, as vegetables themselves are superior to the inorganic particles among and in which they flourish. That they may subsist while they move, their roots, instead of being fixed in the soil, are turned within a cavity, or receptacle, called the stomach, into which appropriate soil or aliment is introduced by the industry of the creature; and, that their powers of loco-motion may be exerted with safety and advantage, they are provided with senses for smelling, tasting, feeling, and seeing their food, and with a faculty of hearing dangers they cannot see. They likewise are enabled to profit by experience in powers of association, of reasoning analogically, and of willing in accordance with their judgments; and they are governed by an habitual desire to associate in species, accompanied by moral feelings, resulting from obligations of mutual deference and convenience."

Herein we again witness (humanly speaking) a series of natural miracles, a permanent connexion between external objects, and the sensations, reasoning, and conduct of the organized being. We trace the animal frame to two constituent parts—the one mechanical, the other sensitive; the mechanical consisting of bones, skin, stomach, blood-vessels, glands, and intestines, provided with muscles and sinews for voluntary motion; and the sensitive, consisting of nerves and brain, which direct the motions by the feelings of the organs of sense—the results of the union constituting creatures whose essence is perception, springing from a system of brain and nerves, which, being nourished by the energies of circulating fluids, moved by a contrivance of muscles, and strengthened by an apparatus of bones, produce all those varieties of feeling, durable, moving, and powerful beings, whose functions continue as long as the original expansive powers balance the unceasing inertia of their materials.

But, of the origin of that *subtle principle* of power which enables beings to fix atoms, and distinguishes *organic life* from *inert matter;* that principle of individuality which generates the passion of self-love, and leads each individual to preserve and sustain its own existence—that principle which gives peculiar powers of growth and maturity to germs of vegetables and animals—and that principle, which, being stopped, suspended, or destroyed, in the meanest or greatest of them, produces the awful difference between the living and the dead; we have no knowledge, and we seem incapable of acquiring any, by the limited powers of our senses. Whether this principle of vitality is a principle of its own kind, imparted from parent plants and animals to their germs; or whether it is the result of the totality of the being, like the centre of a sphere—are questions which must, perhaps, ever remain undetermined by the reasoning powers of man.

I look around me on this book of Nature, which so eloquently speaks all languages; and which, for every useful purpose, may be read, without translation or commentary, by the learned and the unlearned of every age and clime. But my imagination is humbled on considering my relative and limited powers, when I desire to proceed from phenomena to causes, and to penetrate the secrets of Nature below the surfaces of things. I feel a desire to know more than my intellectual vision enables me to see in this volume of unerring truth. I can discover only the mere surfaces of things by the accidents of light; I can feel but the same surfaces in the contact of my body; and my conclusions are governed by their reciprocal relations. In like manner, I can hear, taste, and smell, only through the accidents of other media, all distinct from the nature of the substances which produces those accidents. In fact, I am the mere patient of certain affectations of my senses, and I can know nothing beyond what I derive from my capacity of receiving impressions therefrom. Alas, how little do I know! how much is there, of which I am, and ever must continue, ignorant! How much more am I incapable of knowing, with my limited organs of sense, than I might know, were their capacity or their number enlarged. How then can a being, so limited in ability, presume to examine Nature beyond the mere surface? How can he measure unseen powers, of which he has no perception, but in the phenomena visible to his senses? How can he reason on the causes of effects by means of implements which reach no deeper than the accidents produced by the surfaces of things on the media, which affect his senses, and which do not come into contact with the powers that produce the phenomena?

Without presuming, however, to argue on premises which finite creatures cannot justly estimate, we may safely infer, in reference to the world wherein we are placed, that all things which do exist, owe such existence to their compatibility with other existences; to the necessary fitness of all existing things; and to the harmony essential to the existence of any thing in the form and mode in which it does exist; for, without reciprocal compatibility, without individual fitness, and without universal harmony, nothing can continue to exist that does exist; and, therefore, what does exist, is for the time necessarily compatible with other existences, fit or not incompatible, and in harmony with the whole of co-existent being. Every organized existence affords, therefore, indubitable evidence of final causes or purposes, competent to produce or sustain it; of certain relations of fitness to other beings; of compatibility with other existences; and of harmony in regard to the whole. And every case of destruction affords evidence, that certain final causes have become unequal to their usual office; that the being is unfit to exist simultaneously with some other beings; that its existence is incompatible with certain circumstances; or, that it is contrary to the general harmony of co-existent being. Thus all possible changes, compositions, or divisions of figure, are still nothing but figure; and all possible compositions, or effects of motion, can eternally be nothing but motion; consequently, if there ever had been a time when there was in the world only matter and motion, there never could have arisen any thing else besides matter and motion; and it would have been as impossible for there to have ever existed such faculty as intelligence or consciousness, as it would now be for motion to be blue or red, or for a triangle to be transformed into a sound. The primary cause of the most common existence, we cannot comprehend; and, in short, we cannot look into any one branch of knowledge, but we shall meet with subjects above our comprehension.

In his early state, ignorant of the true system of beings, man supposed a chain between Deity and Nature, whose gradual links were imperceptible. That which lives, must feel; that which feels, must have conceptions; and that which has conceptions, must have appropriated reason. There certainly is nothing contemptible in the idea which binds each part of existence to its great Creator; whose omniscience and omnipotence are not degraded by allowing the different classes in creation the full exercise of those attributes which he has been graciously pleased to confer upon them.

ZOOPHYTES.

Millions of opening mouths to thee belong,
And every mouth is furnish'd,—or with tongue,
Or branching arms, its luckless prey to seize,
Its filthy paunch to fill.

THE various substances given under this division of our subject, are regarded as assimilating vegetable to animal life; in their progressiveness into stems, their multiplying vitality in their branches and deciduous buds, and in the transformation of their animated blossom-like polypes, endued with spontaneous motion.

Coral.

Coral appears to be, in zoophytes, analogous to bone in other animals. The hardening substance of the madrepores, &c. is carbonate (and, in some instances, with a little phosphate) of lime; and they resemble shells, in being a membranaceous substance thus hardened.

M. Peyssonnel first threw a proper light upon the nature and productions of coral and similar marine substances. He discovered that those bodies which Marsigli imagined to be flowers, were insects inhabiting the coral; for, on taking branches out of the water, the seeming flowers, from a number of white points, (answering to the holes that pierced the bark, and whose radiation resembled the flower of the olive-tree,) entered into the bark, and disappeared; but, upon being restored to the water some hours, became again perceptible. When spread on white paper, they lost their transparency, and became red as they dried. The holes in the bark correspond to small cavities upon the substance of the coral; and, on the bark being removed, an infinite quantity of little tubes appear, connecting the bark with the inner substance, besides numerous small glands adhering; from which issues the milky juice of coral. The holes in the bark are the openings through which come forth the insects that form these substances for their habitation; and the cavities, partly in the bark and in the substance, are their cells. The organs of the animal are in the tubes, the glandules are the extremities of its feet, and the milky liquor is its blood and juice, abundant in proportion to its health and vigour. This juice runs along the furrows perceived upon the proper body of coral, and, stopping by little and little, becomes fixed and hard, and is changed into stone; and, being stopped in the bark, the coral increases proportionably in every direction. The insects, when dead, corrupt, and give to water the smell of putrid fish.

In forming coral, and other marine productions of this class, the animals labour like those of the testaceous kind, each according to his species; and their productions vary according to their several forms, magnitudes, and colours. The islands in the South-sea are mostly coral rocks, covered over with earth. The little creatures, whose sensation is scarcely enough to distinguish them from plants, from the bottom of that sea, too deep to be measured by human art, build up a rocky structure, till it reaches the surface. Some coralline islands appear much older than others; particularly the Friendly Islands; and probably, as these submarine works are in constant progress, new islands may at times be produced. The coral insect, or polype, expands in water, and contracts in air; or when touched with the hand in water, or when acid liquors are poured upon it: and they have been observed to move their claws or legs, and expand themselves, when the sea-water containing coral was placed near the fire; and to keep them in their expanded state when separated from the coral in boiling water. Broken branches of coral have been observed to fasten to other branches, and have continued to grow; which also is the case when they are connected with detached pieces of rock and other substances, whence no nourishment could be derived. The coral insects in their cells, not having been injured, continue their operations; and, as they draw no nourishment from the stone of the coral, they are able to increase in a detached and separate state. Coral was found to be equally red in the sea as out of it; and more shining when just taken out of the water than when polished; and the bark, by being dried, becomes somewhat pale.

Tubipore. This genus consists of a nereis in erect hollow parallel aggregate tubes of various colours; and grows on rocks, stones, and other hard substances. In the *tubipora serpens*, the mass consists of circular parallel tubes, of a roseate colour, progressing upwards, which seems to be its mode of generation, till the offspring become deciduous, and fall off the top, to propagate or plant new colonies. This species is curious, and very minute, being often attached to the stalks of fuci, and with them washed ashore.

Madrepore. This genus consists of a medusa, in lamellate star-shaped cavities, arranged with reference to the stellated construction of their mouths or pores. They are of all colours, from snow-white to roseate, and are found on the rocks in the European and Indian seas. The *madrepora cristata* is of a foliaceous structure, with stellate mouths in the centre, each equally furnished with tentacula. The generic characters are, they are almost of a stony hardness, resemble corals, are usually divided into branches, pervious by many holes or cavities, mostly of a stellar figure.

According to Donati, the madrepora is like the coral as to hardness, which equals bone or marble; the colour is white when polished; its surface has light wrinkles, which run lengthwise of the branches; the centre is cylindrical, often pierced the whole length by two or three holes. From this cylinder are detached about 17 laminæ, which run to the circumference in straight lines; and are cut transversely by other laminæ, forming many irregular cavities; the cellules, composed of these laminæ ranged in a circle, are the habitations of little polypes, extremely tender, generally transparent, and variegated with beautiful colours. Peyssonel observes, that those writers who only considered the figures of submarine substances, denominated the class pierced with holes, *pora;* and those whose holes were large, *madrepora.* He defines them to be, all those marine bodies of a stony substance, without bark or crust, and which have but one apparent opening at each extremity, furnished with rays from the centre to the circumference. The body of the animal of the madrepora, whose flesh is so soft as to divide on the gentlest touch, fills the centre; the head is in the middle, and surrounded by several claws, which fill the intervals of the partitions, furnished with yellow papillæ, and are at pleasure brought to its head. Its head or centre is lifted occasionally above the surface, and often contracted and dilated like the pupil of the eye: he saw all its claws move, as well as its head or centre. When these animals are destroyed, the extremities become white, as the animal occupies the extremity; and the substance is of a stony but more loose texture than coral; formed, like similar substances, of a liquor which the animal discharges; and, some species of the polype of the madrepora are produced singly, and others in clusters.

MILLEPORE. This genus consists of the hydra, in a branched form, of a hard structure, and full of turbinate holes, not stellate or radiated, in which it differs from the madrepores. The animal forms, inhabits, and occupies the substance; and the milleporæ grow upon each other; their little animals produce their spawn; which attaching itself either to the extremity of the body already formed, or underneath it, much varies the form of this production. Hence the different shapes of the millepora, composed of innumerable cells of those little insects, which all together exhibit different figures, though every particular cellula has its essential form, and the same dimensions, according to its own species. Some are very beautiful, of various tints, and a fine polish, occasionally as with a rich silver varnish, and others pale yellow and grey. The *millepora truncata* is a beautiful white coral, growing erect, with dichotomous truncate branches, at whose ends are the pores or mouths of the polype; often variegated with a tint of yellow or grey, highly polished, and as if varnished.*

The common coral of the shops belongs to this genus; the *millepora polymorpha.* See vol. iii.

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* Of the three kinds of coral, red, white, and black, the black is the rarest, and most esteemed; the red was formerly used as a medicine. When coral is newly taken out of the sea, the small protuberances are soft, and yield a milky juice which effervesces with acids. The cortical part, with which the coral is all over covered, is less compact than the internal, and, while fresh, may easily be taken off; and from this it is usually freed before brought to market. The Divers say, that the little branches are found only in the caverns whose situation is parallel to the earth's surface, and open to the south. The manner of fishing is this:—Seven or eight men go in a boat, commanded by the patron, or proprietor; and when the net is thrown by the caster, the rest work the vessel, and help to draw the net in. The net consists of two rafters cross-wise, with leads fixed, to which is fastened a quantity of hemp, twisted loosely round, and intermingled with some large netting. This instrument is let down where they think there is coral; and, when the coral is strongly entangled in the hemp and netting, pulled up again. For this purpose, six boats are sometimes required; and, if in hauling in, the rope happens to break, the fishermen run the hazard of being lost. The fishermen divide the tract in which they fish, into ten parts; only in one of which do they fish one season, nor in that again till the ten years are expired. This interval they regard as requisite for the coral to acquire full size and consistence; and the colour acquires intenseness with the length of time allowed for growth. Before the fishers go to sea, they agree for the price of the

The CELLIPORE is a hydra, with a membranaceous habitation, composed of round cells, with the mouths margined or fringed with spines or teeth. In the ISIS, or *red coral*, the polype resembles a plant; the stem bony and jointed, covered by a soft, cellular, porous flesh, and the mouths, or pores, beset with oviparous polypes. This kind is much valued, especially when of a beautifully branched form, covered with small scarlet prominent cells, occupied by the animal. Some naturalists consider this the *true coral.* The ANTIPATHES, or *dark coral*, grows in the form of a plant, having the stem expanded at the base, internally horny, covered with small spines, externally coated with a gelatinous flesh, beset with numerous productive tubercles; some being exceedingly curious and beautiful.

BLACK CORAL *(gorgonia antipathes).* This is the most elegant of the kind, including the beautiful black coral of commerce. The animal appears resembling a plant, shrubby, with erect, alternate, panicled branches, composed of glassy fibres, the bone with flexuous striæ, tapering, dilated at the base, covered with a vascular or cellular flesh or bark, and becoming spongy and friable when dry, leaving naked the interior bone, or coral; the mouths or florets covering the surface of the stem, producing polypes; and occasionally two or three feet high. In the *nobilis*, or red gorgon, the stem has irregular, slightly-tapering branches; with the flesh beautifully red, soft, slippery, and full of very minute pores or florets, irregularly placed, and rather prominent, consisting of eight valves, whence proceed the polypes, with eight tentacula, or feelers; bone stony, and irregularly striate; it is much valued, and grows to the height of ten or twelve inches. They differ from fresh-water polype in many of their qualities, and particularly in pro-

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coral, which is sometimes more, sometimes less, a pound; and they engage, on pain of corporal punishment, that neither they nor their crew shall embezzle any, but deliver the whole to the proprietors. When the fishery is ended, which amounts, one year with another, to twenty-five quintals for each boat, it is divided into thirteen parts; of which the proprietor has four, the casters two, and the other six men, one each; the thirteenth belongs to the Marseilles company, as payment for the boat furnished by them.

ducing from their own substance a hard and solid support, (serving many of the purposes of the bone in other animals,) formed by a concreting juice, thrown out from a peculiar set of longitudinal parallel tubes, running along the internal surface of the fleshy part; in the coats of these tubes are numerous small orifices, through which the osseous liquor exudes, and, concreting, forms the hard layers of the annular circles. The surface is composed of a kind of scales, so well adapted to each other, as to serve for defence from external injuries: and the flesh, *bark*, or *cortex*, consists of proper muscles and tendons for extending the opening of their cells; for sending forth their polype suckers in search of food; for drawing them in suddenly, and contracting the sphincter muscles of these starry cells, to secure these tender parts, and also of proper secretory ducts, to furnish and deposit the osseous matter, which forms the stem and branches, as well as the base of the bone. Mr. Ellis affirms, that there are ovaries in these animals, and thinks it very probable that many of them are viviparous.

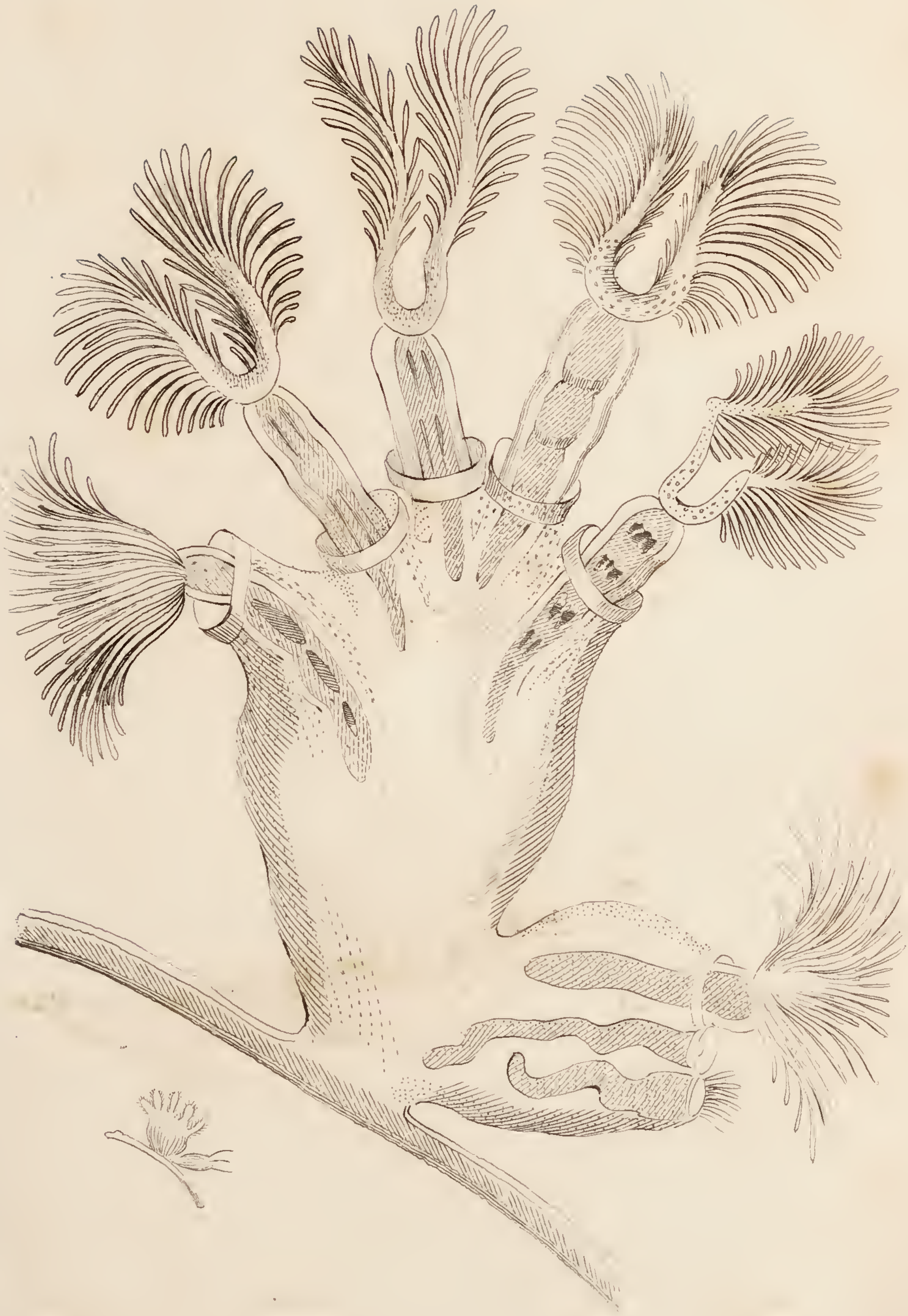
VENUS FAN. This species of the gorgan coral is most beautifully and delicately reticulated, with the branches compressed on the inner side; the bark participating various shades of colours while the animal is alive; bone blackish, horny, and slightly striate on the larger branches; it is flexile, horny, and dark coloured, the older bark whitish or dirty grey; the pores, florets, or mouths, are irregularly placed, but generally in the form of a quincunx; the trunk and branches are pinnate; and, by means of the smaller branches bending together, there is formed an elegant kind of net-work. The polypes have eight claws; and their habitation exists in most seas, of various sizes, often several feet high, and expanded into a large fan-shaped surface, which, from its peculiarly beautiful and delicate structure, is generally called *Venus' Fan.*

The ALCYONIUM is named from the supposed resemblance of some of the species to the nest of the *halcyon*, or kingfisher. The form varies with different species, the animal is plant-like, the stem fixed, fleshy, gelatinous, spongy or coriaceous, beset with productive stellate cells. The *Upright Alcyonium* is of an erect cylindrical form, rather pointed at the top, and covered with innumerable stellate cells, whence are projected the feelers or tentacula of the animal in seeking food. The colour is at first red, slightly tinged with yellow; and, when mature, a gold yellow, with bright red under the epidermis. In the *massa*, or lump, it is reddish, with five yellow stellated shells, having black apertures, the mouths of the polypes.

The *Devil's Claw* is a very curious large species, of a reddish brown colour, irregularly shaped, and rising upwards into numerous smooth obtuse finger-like projections, pointing forwards, and perforated, with stellate tentacula round the orifices, which are the mouths of the polypes. It is found on the coast of Iceland.

The SEA FIG is formed of lobes, resembling lings, of a livid or dark olive colour, beset with innumerable stellate cells, so very minute that the six rays in each are distinguishable only by the microscope. One of these cells, on being carefully dissected, seemed of a fleshy substance, the inside containing numerous little bags, of a pale yellow colour, full of a clear viscid liquor, in the midst of which was a small duct, leading to the cell or star outside. There were also observed several regular figures, formed like minute shells, arranged in the inner tube or duct, and placed one upon another. Whether it was the stomach, with the food of the animal, taken in by the orifice above; or the ovarium, with its young, could not be ascertained.

The SEA MAT.—This animal is a polype proceeding from porous cells; the stem is fixed, foliaceous, membranaceous, of numerous rows of cells, united, or woven, like a mat. It is papyraceous, with cells on both sides, the tops of the branches truncate, like the edge of an axe; of a thin, semi-transparent texture, resembling fine paper, of a light straw colour; sometimes the tops of the branches are digilated, or else irregularly divided; the cells are oblong square; and, when magnified, seem surmounted by sharp denticles, with a long bristle in the front of each, bending inwards like a horn, the mouths incline for-



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CAMPANULATED TABULARIA.

wards, and their whole substance appears full of small points.

The TABULARIA *(magnificata,)* is a very beautiful species, and the largest of the genus. In the quiescent state it much resembles a thin dry cylinder; from the tube, which is annulated and wrinkled, the animal protrudes its tentacula, which, like the rest of the kind, it has the faculty of drawing at pleasure within the tube, and the tube itself within the rock on which it resides. It inhabits rocks in the West Indies; the other sorts are generally spread in the different seas.

SPONGE. This is a remarkably curious production in animated nature; mostly of a light orange or lemon colour, slightly branched, and thickened round the pores. It inhabits all seas, grows at the foot of rocks or any firm substance, and is often seen floating in fine weather. It is fixed, flexible, and very torpid, growing in a variety of forms, composed either of reticulated fibres, or masses of small spines interwoven together, and clothed with a living gelatinous flesh, full of small mouths or holes on its surface, by which it sucks in and throws out the water. The British species are given in Vol. iii.

So early as the days of Aristotle, sponges were supposed to possess animal life; the persons employed in collecting them, having observed them shrink when torn from the rocks; thus exhibiting symptoms of sensation. The same opinion prevailed in the time of Pliny; but no attention was paid to this subject, till Count Marsigli declared they were vegetables. Peyssonell, in two papers sent to the Royal Society in 1752 and 1757, affirmed they were not vegetables, but the production of animals; and accordingly described the animals, and their process of making the sponges. Ellis, in 1762, took great pains to discover these animals: he dissected the spongia urens, and was surprised to find a great number of small nereis or sea scolopendra, which had pierced their way through the soft substance of the sponge, in quest of a safe retreat. That this was really the case, he was fully assured of, by inspecting a number of specimens of the same sort of sponge, just fresh from the sea. He put them into a glass filled with sea-water; and then, instead of seeing any of the little animals which Dr. Peyssonell described, he observed the papillæ, or small holes with which the papillæ are surrounded, contract and dilate themselves. He examined another variety of the same species of sponge, and plainly perceived the small tubes inspire and expire the water. He therefore concluded, that the sponge is an animal, and that the ends or openings of the branched tubes, are the mouths by which it receives its nourishment, and discharges its excrements.

LECTURE XXXII.

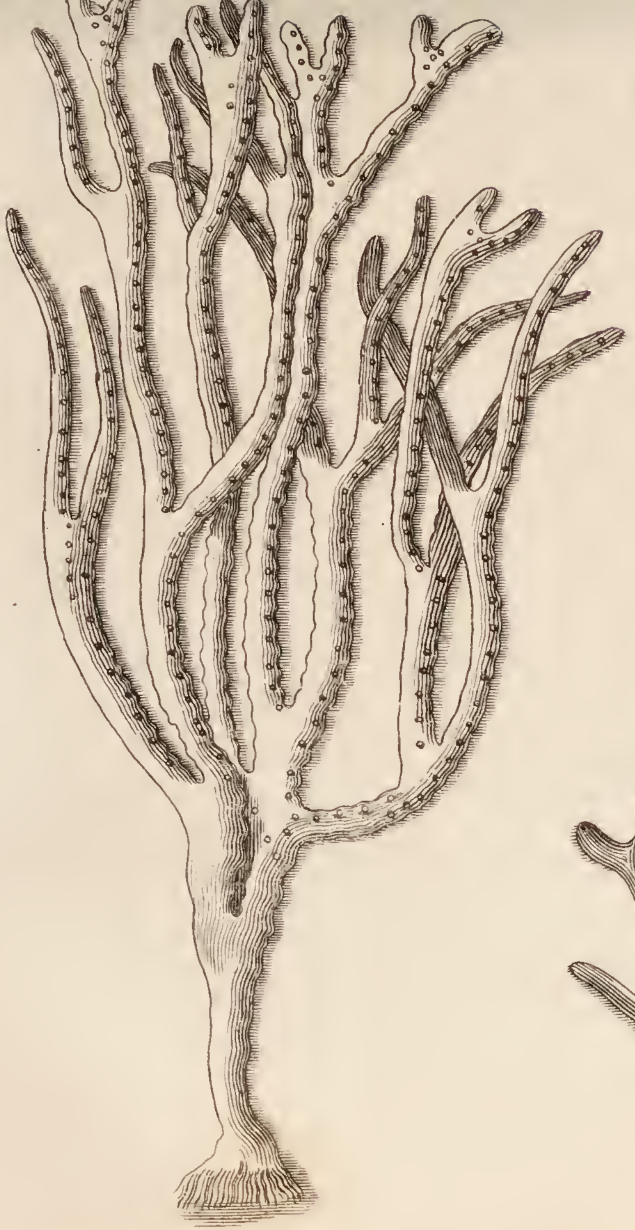
THE FUCI GENUS

Appear to come next to sponge, though generally supposed to belong to the vegetable class. The most extraordinary kinds are:—

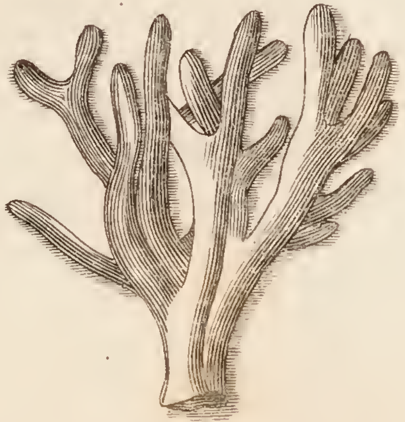
1. The Serrated Fucus *(serratus)*, or sea-wrack; frequent at all seasons of the year, upon the rocks at low-water mark, but produces its seeds in July and August. It consists of a flat, radical, and dichotomous leaf, about two feet long; the branches half an inch wide, serrated on the edges with unequal dents, and at unequal distances, having a flat stalk or rib, divided like the leaf, and running in the middle through all its various ramifications. A small species of coralline, the *Sertularia pumila,* frequently creeps along the leaf. All the species of fucus afford a quantity of impure alkaline salt, but this much less than some others; eight ounces of the ashes yielding only three of fixed salt. The Dutch cover their crabs and lobsters with this fucus, to keep them alive and moist; and prefer it to any other, as destitute of those mucous vesicles with which some of the rest abound, and which soon ferment and become putrid.

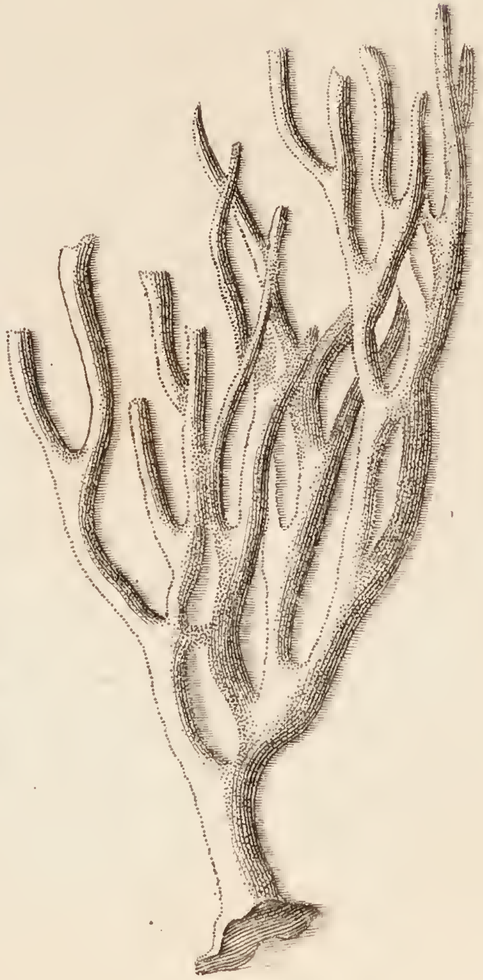
2. The Bladder Fucus *(vesiculosus)*, common sea-wrack, grows in great abundance on the sea-rocks about low-water mark; producing its fructifications

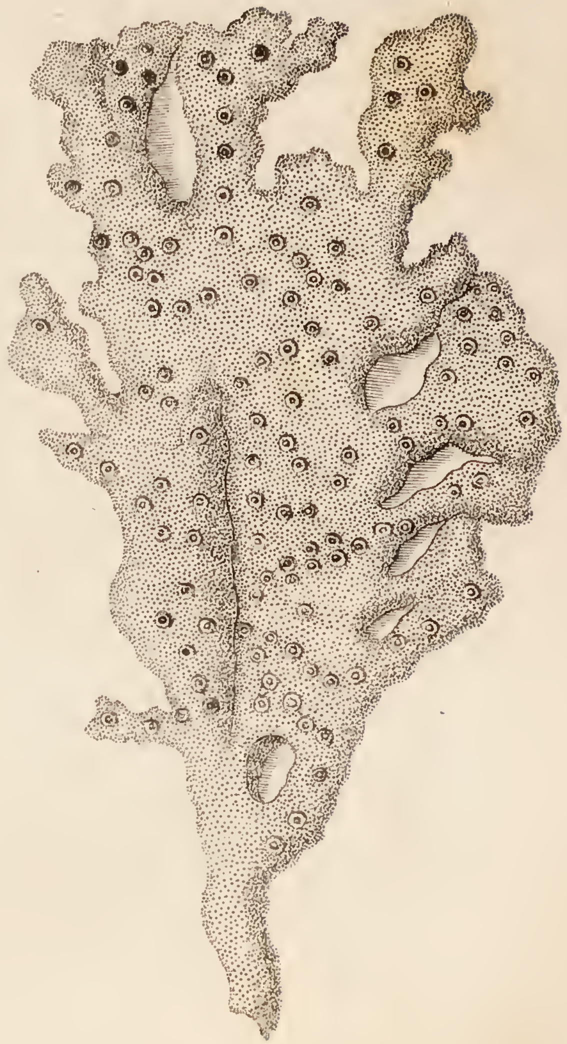
SPONGES.



Madrepore







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in July and August. It has the same habit, colour, and substance, as the preceding, but differs in these particulars—the edges of the leaf have no serratures, but are quite entire; in the disc, or surface, are immersed hollow, spherical, or oval air-bladders, generally in pairs, hairy within, but often single in the angles of the branches, which are most probably air-bladders destined to buoy up the plant in the water; and on the summits, or extreme segments of the leaves, appear tumid vesicles, about three-quarters of an inch long, sometimes oval and in pairs, sometimes single and bifid; with a clear viscid mucus, interspersed with downy hairs. This species is an excellent manure for land; for which purpose it is often applied in the maritime parts of Scotland and other countries. In the islands of Jura and Skye, it frequently serves as winter-food for cattle, which, to seek for it, regularly come down to the shores at the recess of the tides; and sometimes, after a storm, the stags also have been observed to descend from the mountains to feed upon it. The inhabitants of Gothland, in Sweden, boil this fucus in water, and, mixing therewith a little coarse meal or flour, feed their hogs with it; and therefore call the plant *swinetang*. And in Scania the poor people cover their cottages with it, and sometimes use it for fuel. In Jura, and some other of the Hebrides, the inhabitants dry their cheeses without salt, by covering them with the ashes of this plant; which so abounds with salts, that five ounces of the ashes give two ounces and a half of fixed alkaline salts, or half of their whole weight But the most beneficial and economical use to which this fucus is applied, is in making pot-ash or kelp, much practised in the Western Isles. There is great difference in the goodness and price of this commodity, and much care and skill required in properly making it. That is the best which is hardest, finest grained, and free from sand or earth. The price of kelp in Jura is *3l. 10s* per ton, and from forty to fifty tons are exported annually. So great a value do the inhabitants of that place set upon this fucus, that they have sometimes rolled fragments of rocks and huge stones into the sea, to invite the growth of it. Its medicinal virtues have been much celebrated by Russel, in his Dissertation concerning the use of Sea-water in Diseases of the Glands. The saponaceous liquor, or mucus, in the vesicles, are an excellent resolvent, extremely serviceable in dispersing all scorbutic and scrofulous glandular swellings. The patient may rub the tumor with these vesicles bruised in his hand, till the mucus has thoroughly penetrated the part, and afterwards wash with sea-water: or he may gather two pounds of the tumid vesicles in July, when they are full of mucus, and infuse them in a quart of sea-water, in a glass vessel, for fifteen days, when the liquor will have acquired nearly the consistence of honey; then strain it through a fine linen cloth, and with the hand rub this liquor, as before, three or four times a-day, upon any hard or scrofulous swellings, washing the parts afterwards with sea-water. Even scirrhosities in women's breasts have been dispelled by this treatment. By calcining the plant in the open air, is made a very black salt powder, called vegetable æthiops; a medicine much used as a resolvent and deobstruent, and recommended also as an excellent dentifrice, to correct the scorbutic laxity of the gums, and to take off the foulness of the teeth.

3. The matted or INDIAN GRASS *(plicatus)* grows on the sea-shores in many places both of Scotland and England. It is generally about three or four to six inches long. Its colour, after exposure to the sun and air, is yellowish or auburn; its substance pellucid, tough, and horny, so as to resemble what anglers call Indian grass, the tendrils issuing from the ovary of the dog-fish.

4. The palmated or SWEET FUCUS *(palmatus)*, commonly called *dulse* or *dilse*, grows plentifully on the sea-coasts of Scotland and the adjoining islands. Its substance is membranaceous, thin, and pellucid; the colour red, sometimes green with a reddish mixture; its length is generally about five or six inches, but varies from three inches to a foot; its manner of growth, fan-shaped, or gradually dilated from the base upwards. Its divisions are extremely various. The inhabitants of both Scotland and England with pleasure eat this plant, without expecting any medi-

cinal virtues from it. The inhabitants of the Archipelago also are fond of it: they sometimes eat it raw, but most esteem it when added to ragouts, oglios, &c. to which it gives a red colour; and, on dissolving, renders them thick and gelatinous. In the Isle of Skye, it is sometimes used in fevers, as a sudorific, being boiled in water with a little butter; this also frequently purges. The dried leaves, infused in water, exhale the scent of violets.

5. The EATABLE FUCUS, *(esculentus,)* or bladder-locks, called *tangle* in Scotland, is a native also of the British shores. It is commonly about four feet, but is sometimes found three yards or more in length, and seven or eight inches to a foot in width. Small specimens are not above a cubit long, and two inches broad. The substance is thin, membranaceous, and pellucid; the colour green or olive; the root consists of tough cartilaginous fibres; the stalk is about six inches long, and half an inch wide, nearly square, and pinnated in the middle between the root and origin of the leaf, with ten or twelve pair of thick, cartilaginous, oval-obtuse, crowded, foliaceous ligaments, each about two inches long. The leaf is of an oval-lanceolate, or long elliptic form, simple and undivided, waved on the edges, and widely ribbed in the middle from bottom to top, the stalk running through its whole length, and standing out on both sides. This fucus is eaten in the north by both men and cattle. Its proper season is September, when it is in greatest perfection. The membranous part is rejected, and the stalk only is eaten. It is recommended in the disorder called *pica,* to strengthen the stomach, and restore the appetite.

6. The SWEET FUCUS, *(saccharinus,)* or sea-belt, is very common on the sea-coast. The substance is cartilaginous and leathern, and the leaf is ribless; which characters distinguish it from the preceding, to which it is allied. It consists only of one simple, linear, elliptic leaf, of a tawny-green colour; in its full-grown state, about five feet long, and three inches wide, but so varies as to be found from a foot to four yards in length. The ordinary length of the stalk is two inches; but it varies even to a foot. The root

consists of branched fibres, which adhere to the stones like claws. This plant is often infested with the Sertularia ciliata. The inhabitants of Iceland make a kind of pottage of it; boiling it in milk, and eating it with a spoon. They also soak it in fresh water, dry it in the sun, and then lay it up in wooden vessels, where it is soon covered with a white efflorescence of sea-salt, which has a sweet taste like sugar. This is eaten with butter; but, if taken in too great a quantity, the salt is apt to irritate the bowels, and bring on a laxity. Their cattle feed well upon this plant, both in its recent and dry state; but their flesh acquires a bad flavour. It is sometimes eaten, boiled as a pot-herb, by the people on the coast of England.

7. The CILIATED OR LIGULATED FUCUS *(ciliatus,)* is found on the shores of Iona, and in other places, but is not common. The colour is red; the substance membranaceous and pellucid, without rib or nerve; the ordinary height of the whole plant about four or five inches. Its appearance varies according to the different stages of its growth; and it is eaten by the Scots and Irish, promiscuously with the fucus palmatus, or dilse.

8. The PROLIFEROUS FUCUS *(prolifer,)* is found on the shores of the western coast, adhering to shells and stones. The colour is red; the substance membranaceous, but tough, and somewhat cartilaginous, without rib or nerve, though thicker in the middle than at the edges. The whole length is about four or five inches; the breadth of each leaf about a quarter of an inch. The growth, when examined attentively, seems extremely singular and wonderful. It originates either from a simple, entire, narrow, elliptic leaf, or from a dilated forked one, about an inch and a half long. Near the extremity of the surface of the elliptic leaf, or the points of the forked one, arises one or more elliptic or forked leaves, which, in the same manner, produce others similar near their summits; and so on continually, one or more leaves from near the ends of each other, in a poliferous and dichotomous order, to the top of the plant; which, in the manner of its growth, much resembles the flat-leaved Indian fig, *(cactus opuntia.)* Sometimes, but

not very often, two or three leaves, or more, grow out of the middle of the disc of another leaf. The fructifications are red, spherical, rough warts, less than the smallest pin's head, scattered without order, on the surface of the leaves. These warts, when highly magnified, seem the curled rudiments of young leaves, which, in due time, either drop off and form new plants, or continue on, and germinate upon the parent. This plant is very much infested with the flustra pilosa, the madrepora verrucaria, and other corallines, which make it appear as if covered with white scabs.

9. The Jagged Fucus, *(pinnatifidus,)* or pepper-dilse, is frequent on sea-rocks which are covered by the tides, both on the eastern and western coasts. It is of a yellow olive-colour, often tinged with red. The substance is cartilaginous, but yet tender and transparent; the height about two or three inches. This fucus has a hot taste in the mouth, and is therefore called *pepper-dilse* by the people in Scotland, who frequently eat it as a salad, similarly to the palmatus.

10. The Pectinated Fucus *(plocamium,)* is frequent on the sea-rocks, and in basins of water left by the recess of the tides. Its natural colour is a most beautiful bright red, or purple, but is often variegated with white or yellow. Its substance is cartilaginous, but extremely thin, delicate, and transparent; its height commonly about three or four inches. The stalk is compressed, about half a line in diameter, erect, but waved in its growth, and divided, almost from the base, into many widely-expanded branches, very long, alternate, exactly like the stalk, and subdivided into alternate secondary branches, again frequently compounded in like manner, and these divisions decorated with subulated teeth, growing in alternate rows, curiously pectinated, or finely toothed, on the upper side, like a comb; the smallest of these teeth scarcely visible to the naked eye. The fructifications are minute spherical capsules, or smooth dark-red globules, scattered on the sides of the branches; generally sessile, but some few supported on short peduncles. This fucus, on account of its elegant co-

lours and fine divisions, is most admired by the ladies who are fond of pictures and mimic landscapes composed of marine vegetables.

11. The Thread Fucus, (*filum,*) or sea-laces, is found on many parts of the coast, on the sea-rocks, and waving under the water like long strings. The substance is opaque and cartilaginous, but not difficult to be broken. The colour, when recent, a dull olive-green; when dry, fuscous, or nearly black; and, when exposed to the sun and air for some time on the shores, it becomes yellow, straw-coloured, or white. It consists only of a simple, unbranched, naked, cylindrical stalk, three or four yards long, from the size of a large fiddle-string, to that of a thick whip-cord; smallest at the base and summit; smooth on the outside, full of mucus, often twisted, and always intercepted by numerous transverse diaphragms, visible when the plant is held between the eye and the light. The fructifications have not yet been discovered; but, from the transverse septa in its structure, it is supposed to be conferva. The stalks, thinned when half dry, and twisted, acquire such strength and toughness, as to be often used by the Highlanders instead of Indian grass.

12. The Gigantic Fucus (*giganteus,*) grows in the Straits le Maire, on rocky ground, there distinguished from sand, or ooze, by the enormous length of the sea-weeds which grow upon it. The leaves are four feet long, and some of the stalks, though not thicker than a man's thumb, are 120. Some, sounded over by Sir J. Banks and Dr. Solander, were eighty-four feet long, and, as they made a very acute angle with the bottom, they were thought to be at least one half longer.*

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* As some species of the fucus, when dried and preserved, are extremely beautiful, the curious, and especially those who prosecute the study of botany, may be anxious to know the best method of preserving them, without destroying their colour and beauty. The following is recommended: Take a sheet of stout paper, or pasteboard, and varnish both sides; and, having rowed in a boat to the rock where the fucus abounds, plunge your varnished paper into the water, and, detaching the fucus, receive it thereon. Agi tate the paper gently in the water, that the plant may be properly

CORALLINES.

THE precise link which connects the animal and vegetable kingdoms, has not yet been ascertained; but Corallines seem to come nearest thereto, of any known substance; still the calcareous covering, though extremely thin, proves that they are not vegetables. The minuteness of the pores of corallines, though as small as those of some plants, does not constitute them vegetables. The different species of corallines are the work of an infinite number of minute polypes, which form their habitations as bees do their combs; only differing in the combs being always of one shape, and the corallines assuming various figures. The little creatures issuing from the cells in the sides, and expanding their tender transparent arms in search of food, were supposed to be flowers in the act of blowing; and, from their receding when disturbed, they were supposed to partake the nature of the sensitive plant.

These bodies consist of many slender finely divided and jointed branches, resembling some species of moss; or animals growing in the form of plants, having their stems fixed to other bodies; these stems are composed of capillary tubes, whose extremities pass through a calcareous crust, and open into pores on the surface. The branches are often jointed, and always subdivided into smaller branches, either loose and unconnected, or joined as if glued together. They are distinguished from plants by their texture and hardness: they also yield, in distillation, a considerable quantity of volatile salt; and their smell, in burning, resembles that of burnt horns and other animal substances. Many seem to consist of a single tube, containing a single pa ent animal. Every

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spread over it, and lift them softly out of the water; then with pins fix the strong stalks, that they may not be displaced, and leave the plant lying upon the varnished paper, to dry in the open air. When it is fully dry, the different parts will retain their position, and the plant may be preserved within the leaves of a book. To free it from the slime and salt which adhere, wash it gently in fresh water, after being removed from the rock on which it grew.

branch emitted contains an offspring of this parent, dependent upon it, yet capable of producing its like, in the emission of a new branch. Others consist of many such tubes, rising up together, and encircling the deserted tubes of their progenitors, whose exuviæ become the substratum of a rising generation. Mr. Ellis distributes corallines into the *vesiculated*, *tubular*, *celliferous*, and *articulated* kinds.

Vesiculated corallines are distinguished by their horny hollow ramifications; most of them have little denticles on their branches, like leaves on mosses; and at certain seasons have small bodies, like bladders, proceeding from their stems and branches, and differing in form, according to the species. Their colour, when dry, is of a yellowish or pale brown. They are elastic, and are found adhering to rocks, shells, and fucuses, by small root-like tubes: they recover their form in water, after having been dried; and when put into vinegar, they cause no effervescence.

The *trident* is jointed and trichotomous, or with its branches growing in a division of three; the joints compressed, with three fat lobes. The *cock's comb* is dichotomous and hair-like, dividing in twoes, with rounded joints, and its branches disposed in crested bunches, with ovaries at the two inferior divisions. This very elegant subject is seldom more than an inch long, and mostly of a beautiful red colour, though sometimes white. The *conglutinata* is of a sea-green colour, in size about an inch and a half; a single stem, slightly incrustated, with all its branches dichotomous and glued together, but not covered, forming a figure like a fan-shaped leaf. The dichotomous branches are obvious on its surface, and each is covered with a thin calcareous substance full of pores, which, being very near each other, become glued together by their covering. The *large-fan* is the finest, having a single greenish brown or milk-white incrustated stem, with the ramifications glued together, like a fan, covered with a wavy calcareous crust. It varies from the figure of a flat kidney-shaped leaf, an inch high, with a broad stalk, to a large subdivided, lobated, frond-like form, five inches in height and breadth. At the bottom of the stalk is a tuft of fine hair-like tubes, whereby the polype fixes itself to stones or rocks, like the suckers of an oyster.

Tubular corallines are composed of a number of simple tubes, growing up nearly together; or of such branched ones as have neither denticles nor vesicles. These are horny and elastic like the former, and recover their original form in water. Some of them appear wrinkled like the wind-pipe, and others like the intestines of small animals.

The *Mop-like* kind is the most singular of the class, and differs from the others by the regular wrinkles of its single membranaceous stem, which is small at the base, and grows wider as it rises, till it sends forth at the top a full tuft of jointed dichotomous branches, resembling a mop. From the base it sends forth branched tubes, which have regular equal diameter the whole length, and by which it adheres. The branches at top have a calcareous crust, full of pores.

Celliferous corallines appear, when magnified, to be fine thin cells, the habitations of small animals connected, and disposed in a variety of elegant forms like branches. These effervesce with acids.

The *fleshy coralline* is peculiarly remarkable, being jointed, with the branches trichotomous, or divided into three, with compressed wedge-shaped and flesh-coloured joints; supporting a broad fleshy substance on the extremity of each branch, divided into cells, like the comb of bees, each occupied by a separate polype. The *cranifera* is also branched in three, with the joints of the stem compressed and wedge-shaped, and those of the branches roundish; of a beautiful sea-green colour, and slender texture: from these a series of egg-shaped ovaries, with stalks, grow opposite to each other, and are sometimes proliferous; whereby it differs from all others.

The *articulated corallines* consist of short pieces of a stony or cretaceous brittle matter, whose surface is covered with pores or cells, joined by a tough, membraneous, flexible substance, of many small similar tubes compacted. The stony part is soluble in vinegar, and the other part remains entire. The coralline of the shops is trichotomous, or dividing in threes, with the joints of the stem a little compressed, and not unlike a wedge. It is of various colours; red, green, purple, and white; growing in clustered tufts, from two to five inches high, and the thickness of a large thread. It is fixed to rocks and shells by stony joints, which, as they rise, are united to others by extremely fine and slender tubes: these may be discovered by a good eye, or a common magnifier. As the stems extend, they become pennated by side branches, opposite each other, and joined similarly: the joints of this species are like the upper part of an inverted cone, but a little compressed: the whole surface is covered with very minute circular-shaped cells like pores. If a branch of this coralline be put into vinegar, these cells are dissolved with the whole cretaceous surface; and, instead thereof, appear rows of minute ramifications, which seem to have communicated with each of these cells. Upon some specimens of this coralline, are little small figures, like seed-vessels, with which the branches frequently terminate: they are also found on the sides. When a branch is rendered soft, by steeping in vinegar, there may be squeezed out from the little knobs at the ends and sides, small twisted figures. We frequently find this coralline of different colours, as red, green, ash, and white; but, by being exposed to the sun and air on the shore, all of it becomes white.

The SERTULARIA grows in the form of a plant, with a branched stem, producing polypes from cup-shaped mouths or cells; some of the stems being horny, and others crustaceous. They are mostly minute, yet beautiful and curious: the polypes have numerous tentacula, and adhere to fuci and shells. The *Abietina* is found attached to shells, in size three or four inches, and may easily be distinguished by its fir-like appearance and alternate branches, set with minute conical denticles.*

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* If a small portion of this, soon after taken from the sea, be put in a drop of sea-water, on the stage of a single microscope, the polypes will very soon appear extending their arms in search of food. This is a very interesting sight, and well adapted to astonish persons unaccustomed to survey Nature on a small scale. Persons on the different coasts may provide themselves with a vast fund of amusement in the examination of such minute creatures.

The *Sea Pen* is very singular, in the resemblance which several of the species have in their growth and form to the quill feather; whence its name. It is furnished with solitary polypes towards the tip, placed on opposite sides, alternately; the stem thickened and obtuse beneath. The animal is not fixed, but has the faculty of moving, supported by a bony part within, naked at the base; the upper part more or less charged with lateral ramifications, producing polypes from tubular pores; some of them being very beautiful, efflorescing like a panicle of flowers. They emit a very splendid phosphoric light in dark nights.

LECTURE XXXIII.

POLYPES.

HERE we shall introduce that class of zoophytes named *Hydra*, because of its surprising reproductive power. —These diminutive objects may be found, in spring, adhering to all sorts of aquatic plants, and to any loose substances lying in ditches or ponds: one of their most common haunts is under the leaves of duck-weeds; and, when first taken up, they appear so like a small dot of transparent jelly, that they would be disregarded by persons not aware of their curious conformation.

The general character of the polype is, that it fixes itself by its base, is gelatinous, linear, naked, contractile; and can change its place. The mouth, placed at one end, is surrounded by hair-like feelers. The young ones grow from its sides; but in autumn it also produces eggs from its sides. There are six varieties: 1. The *viridis*, or green polype, has commonly ten short arms. 2. The *fusca* has frequently eight arms, several times longer than the body. 3. The *grisea* is of a yellowish colour, small towards the bottom, with about seven long arms. 4. The *pallens* has about six arms of a moderate length. 5. The *hydatula* has a vesicular body, and four obsolete arms. It is found in the abdomen of sheep, swine, &c. 6. The *stentorea* has been called the *funnel-shaped*, and has a mouth surrounded with a row of hairs. 7. The *socialis* is bearded, thick, and wrinkled.

On the three first species have the greatest number of experiments been made; and their shapes are so various, that it is not easy to describe them. They are mostly found in ditches, which, when carefully examined while the sun is very powerful, will exhibit many little transparent lumps of the appearance of a jelly, and size of a pea, and flatted upon one side; and the same kind of substances are also met with on the under side of the leaves of aquatic plants. These are polypes, quiescent, and apparently inanimate. Generally, one end is fixed to some solid substance, and a large opening, the mouth, appears at the other, having several arms fixed round it, projecting as rays from the centre. They are slender, pellucid, of a tender conformation, like the horns of a snail, and capable of contraction into a very small compass, and of considerable extension. The arms are capable of similar contraction and extension; and with these they catch minute worms and other insects, bring them to the mouth, and swallow them; the indigestible parts are again thrown out by the mouth.

The green polype was discovered first by Mr. Trembley; and the first appearances of spontaneous motion were perceived in its arms, which it can contract, extend, and twist about in various directions. On the first appearance of danger they contract so as to appear little bigger than a grain of sand, of a fine green colour, the arms disappearing entirely. Soon afterwards he found the grisea, and then the fusca.

The bodies of the viridis and grisea diminish almost insensibly from the anterior to the posterior extremity; but the fusca is likewise mostly of an equal size for two-thirds of its length, and when it abruptly becomes smaller, and continues of a regular size to the end. These three kinds have from six to twelve or thirteen arms, and the grisea, at times, is found with eighteen arms. They are of various lengths, from half an inch to an inch and a half; their arms are seldom longer than their bodies, though some have them an inch, and others even eight inches long; but they are contractile till their bodies do not exceed one-tenth of an inch in length, and they can stop at any intermediate degree of contraction or extension. Their thickness decreases as they extend, and *vice versa;* and they may be made to contract themselves by either agitating the water which contains them, or touching the animals themselves. When taken out of the water, they all contract so as to seem only a little lump of jelly. They can contract or expand one arm, or any number of arms, independent of the others; and they can bend their bodies or arms in all directions. They can also dilate or contract their bodies in various places, and sometimes appear thick set with folds, which carelessly viewed, appear like rings. Their progressive motion is performed by that power of contracting and dilating their bodies. When about to move, they bend down their head and arms, and lay hold on some other substance, then loosen their tail, draw it towards their head, and either fix it, or stretching forward the head as before, repeat the same operation. Thus they ascend or descend upon aquatic plants, or the sides of the vessel wherein they are kept; they hang at times from the surface of the water, by the tail, or by one of the arms; and they can easily walk on the surface of the water. On examining the tail with a microscope, a small part is found dry above the water, and in a little concave space, of which the tail forms the bottom, so as to seem suspended on the surface of the water on the same principle that a small pin or needle is made to swim. Hence when a polype passes from the sides of the glass to the surface of the water, it needs only to put out of the water that part by which it is to be supported, and to allow it time to dry, which is always done upon these occasions; and they attach themselves so firmly by the tail to aquatic plants, stones, &c. as not to be easily disengaged: they often further strengthen these attachments, by one or two of their arms, which serve as anchors to fix them to the adjacent substances.

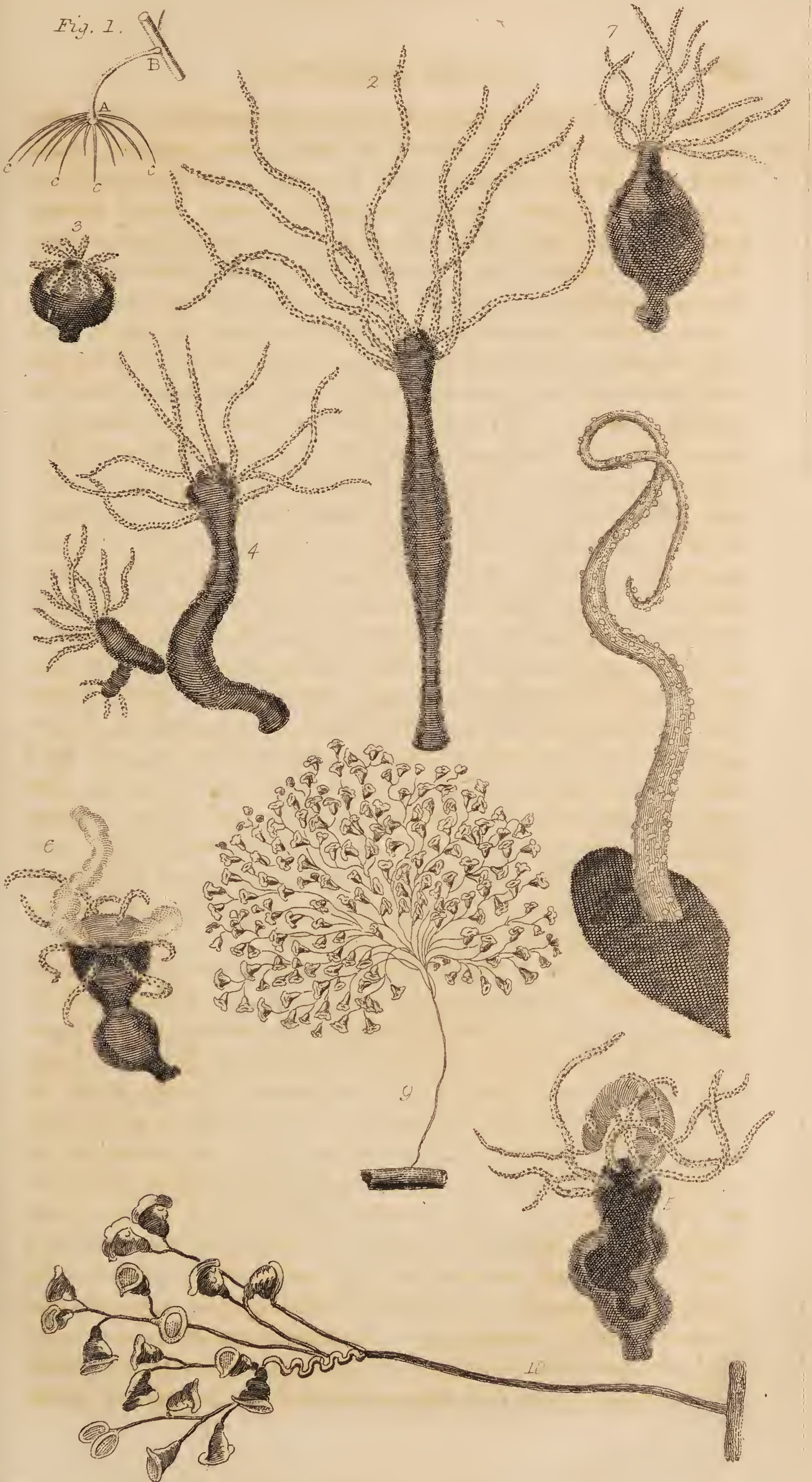
The stomach of the polype, is a kind of bag or gut, into which the mouth opens, and extends from the head to the tail. This, in a strong light, is visible to the naked eye, especially when the animal is placed between the eye and a candle; for whatever their colour, these animals are quite transparent. The stomach, however, appears to more advantage through a powerful magnifier. Mr. Trembley, by cutting one of these animals transversely into three parts, satisfied himself that they were perforated throughout. Each piece immediately contracted itself, and the perforation was very visible through a microscope. The skin which incloses the stomach, is that of the polype itself; so that the whole animal, properly speaking, consists only of one skin, of a tubular form, and open at both ends. No vessels of any kind are distinguishable.

The mouth is situated at the anterior end, in the middle between the shooting forth of the arms, and assumes appearances differing with circumstances; being sometimes lengthened out in the form of a nipple, at others appearing truncated; sometimes the aperture is quite closed, at others there is a hollow; though at all times a small aperture may be discovered by a powerful magnifier.

The skin of a polype, when examined with a microscope, appears like shagreen, or covered with little grains, more or less separated, according to the degree of contraction of the body. If the lips of a polype be cut transversely, and placed so that the cut part of the skin may lie directly before the microscope, the skin throughout its whole thickness seems to consist of an infinite number of grains, and the interior part is more shagreened than the exterior; but they are not strongly united, and may be easily separated. They even separate of themselves, though in no great numbers, in the most healthy animals, but when they separate in large quantities, it is a symptom of a dangerous disorder, in progress of which the surface of the polype becomes gradually rough or more unequal, and no longer well defined or terminated. The grains fall off on all sides; the body and arms contract and dilate, assume a white shining colour, and at last the whole dissolves into a heap of grains; more particularly observable in the green polype. By a careful examination the skin of the polype seems entirely composed of grains, cemented by a gummy substance; but to the grains solely the polype owes its colour. The structure of the arms is analogous to that of the body; and examined by the microscope, they appear shagreened whether contracted or extended; but when very much contracted, they appear more shagreened than the body, though almost quite smooth in their utmost state of extension. In the green polype the arm's appearance continually varies; and the variations are more sensible towards the extremity, than at its origin, but more scattered in the further parts. The extremity is often terminated by a knob, whose hairs can be observed only by a very powerful magnifier. They have a remarkable inclination of turning towards the light; and if that part of the glass on which they are, be turned from the light, they will quickly remove to the other.

The *fusca* has the longest arms, and by the most curious manœuvres seizes its prey. They are best viewed in a glass seven or eight inches deep, when their arms commonly hang down to the bottom. When this, or any other kind, is hungry, it spreads its arms in a kind of circle, to a considerable distance, inclosing in this, as in a net, every insect which has the misfortune to come within the circumference. While the animal is contracted by seizing its prey, the arms swell like the muscles of the human body when in action. Though no appearance of eyes is observed in the polype, they certainly have some knowledge of the approach of their prey, and evince the greatest attention as it approaches them. It seizes a worm the moment it touches one of the arms; and in conveying it to the mouth, frequently twists the arm into a spiral, like a cork-screw; whereby the insect is brought to the mouth much sooner than otherwise it would be; and the insects on which the polypes feed are so soon killed by them, that Fontana thinks they must contain a most powerful poison; for the lips scarce touch the animal ere it expires; nor is any wound perceived on it when dead. The worm, when swallowed, appears sometimes single, sometimes double, according to circumstances. The polype when full, contracts itself, hangs down in a kind of stupor, but extends again as the food is digested and the excrementitious part discharged. The bodies of the insects, when swallowed, are first macerated in the stomach, then reduced into fragments, and driven backward and forward along the stomach, and even into the arms, however fine; whence they appear like the other parts of this remarkable creature, a kind of hollow guts or stomachs. To observe this motion, it is best to feed the polypes with food of a lively colour; as worms furnished with a red juice. Some bits of a small black snail being given to a polype, the substance of the skin was soon dissolved into a pulp of small black fragments; and on examining the polype with a microscope, the particles were observed driven about in the stomach, and into the arms; thence back into the stomach and to the tail, whence they passed again into the arms, and so on repeatedly. The grains of the body take their colour from the food, and become red or black with the colour thereof. They are likewise more or less tinged with these colours, in proportion to the strength of the nutritive juices; and they lose their colour when fed with aliments of a colour different from themselves. They feed on most insects found in fresh water; and will also be supported with worms, the larvæ of gnats, &c. and even with snails, large aquatic insects, and fish or flesh cut into small bits. Sometimes two polypes lay hold of the same worm, and each begins to swallow its own end till their mouths meet, and the worm breaks. But should this not happen, the one polype will sometimes devour the other along with its portion. But the stomach of one polype not being fitted for dissolving the substance of another; the one which is swallowed always gets clear after being imprisoned for an hour or two.

The manner in which the polypes generate, is most perceptible in the grisea and fusca. Examined in summer, when the animals are most active, and prepared for propagation, some small tubercles proceed from the sides, which constantly increase in bulk, until in two or three days they assume the figure of small polypes. When they first shoot, the excrescence is pointed and conical, of a deeper colour than the rest of the body. It soon becomes truncated, then cylindrical, after which the arms shoot from the anterior end. The tail adheres to the body of the parent animal, but diminishes until it adheres only by a point, and is then ready to separate. When this takes place, both the mother and young ones fix themselves to the sides of the glass, and it is accomplished by a sudden jerk.



Forms of Polypi.

The time requisite for the formation of the young ones, differs according to the warmth of the weather, and the nature of the food eaten by the mother. Sometimes they are fully formed, and ready to drop off, in 24 hours; but when the weather is cold, 15 days have been requisite for bringing them to perfection.

There is a reciprocal communication of food betwixt the young and old before separation. The young ones, as soon as they are furnished with arms, catch prey for themselves, and communicate the digested food to the old ones, who do likewise to the young ones. This was fully verified thus: A large polype of the *fusca* kind, being placed on a slip of paper in a little water, the middle of the body of a young one growing out from it, was cut open; when the superior part of that end which remained fixed to the parent was found to be open also. By cutting over the parent polype on each side of the shoot, a short cylinder was obtained, open at both ends; which being viewed through a microscope, the light was observed to come through the young one into the stomach of the old one. On cutting open the cylindrical portion lengthwise, the hole of communication was observed, through the end of the young one. On changing the situation of the pieces, the light was seen through the hole of communication. This may be seen between the parent polype and its young after feeding; for after the parents have eaten, the bodies of the young swell as if themselves had been eating. The polypes produce young ones indiscriminately from all parts of their bodies, and five or six young ones have frequently been produced at once.

Nothing like copulation among these creatures was ever observed by Mr. Trembley, though during two years he had thousands of them under his inspection. To ascertain this subject, he took two young ones the moment they came from their parent, and placed them in separate glasses. Both multiplied, not only themselves, but also their offspring, which were separated and watched similarly to the seventh generation; they have even the same power of generation while adhering to their parent. In this state the parent, with children, and grandchildren, exhibits a singular appearance, looking like a shrub thick set with branches. Thus several generations are sometimes attached all to one parent. Mr. Adams gives a figure of one polype with *nineteen* young ones hanging at it; the whole group being about an inch broad, and an inch and a half long; the old polype ate about twelve monoculi per day, and the young ones about 20 among them.

When a polype is cut transversely, or longitudinally, into two or three parts, each part soon becomes a perfect animal; and so great is this prolific power, that a new animal will be produced even from a small portion of the skin of the old one. If the young ones be mutilated while they grow upon the parent, the parts so cut off will be reproduced; and the same property belongs to the parent A truncated portion will send forth young ones before it has acquired a new head and tail of its own, and sometimes the head of the young one supplies the place of that which should have grown out of the old one. If we slit a polype longitudinally through the head to the middle of the body, we shall have one formed with two heads; and by slitting these again in the same manner, we may form one with as many heads as we please.

A still more surprising property of these animals is, that they may be grafted together. If the truncated portions of a polype be placed end to end, and gently pushed together, they will unite into a single one. The two portions are first joined together by a slender neck, which gradually fills up and disappears, the food passing from the one part into the other; and thus we may form polypes not only from portions of the same but different animals; we may fix the head of one, to the body of another, and the compound animal will grow, eat, and multiply, as if it had never been divided. By pushing the body of one into the mouth of another, so far that their heads may be brought into contact, and kept there for some time, they will at last unite into one animal, only having double the number of arms it would otherwise have had. The *hydra fusca* may be turned inside out like a glove, at the same time that it continues to live and act as before. The lining of the stomach now forms the outer skin, and the former epidermis constitutes the lining of the stomach. If, previous to this operation, the polype have young ones attached to it, such as are but newly beginning to filiate, turn themselves inside out, while the larger ones continue to increase in size till they reach beyond the mouth of the parent, and are then separated in the usual manner from the body. When thus turned, the polype combines itself in various ways: the fore part frequently closes, and becomes a supernumerary tail. The animal, which was at first straight, now bends itself, so that the two tails resemble the legs of a pair of compasses, which it can open and shut. The old mouth is placed at the joint, but loses its power of action; to supply which, a new one is formed on its neighbourhood; and in a little time a new species of hydra is produced with several mouths.

The sides of a polype, which has been cut through longitudinally, begin to roll up, commonly from one of the extremities, with the outside of the skin inwards; but in a little time they unroll, and the two cut edges join, sometimes beginning at one extremity, and sometimes approaching through the whole length. As soon as the edges join, they unite so closely that no scar can be perceived. If a polype be partly turned back, the open part closes, and new mouths are formed in different places. Every portion of a polype is capable of devouring insects almost as soon as it is cut off; and the voracity of the whole genus is astonishing; for most of the insects on which they feed bear the same proportion to the mouth of a polype, that an apple of the size of a man's head bears to his mouth.

The *Hydra pallens* is very rarely met with. It is of a pale yellow colour, growing gradually smaller from the bottom; the tail is round or knobbed; the arms are about the length of the body, of a white colour, generally seven in number, apparently composed of a chain of globules. The young are brought forth from all parts of its body.

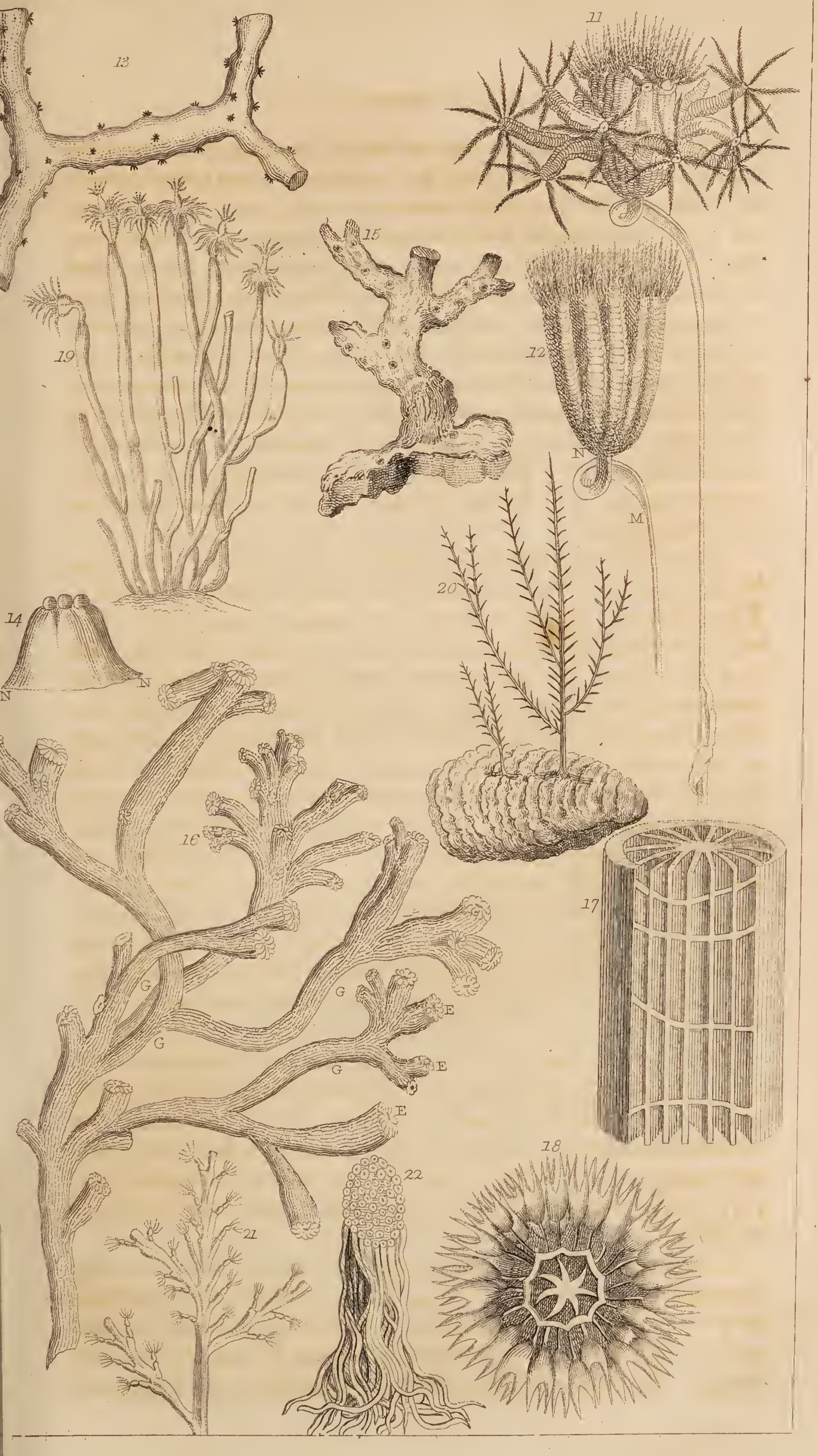
The *hydratula* is mentioned by many medical writers. Dr. Tyson, in dissecting an antelope, found several hydatides or films, about the size of a pigeon's egg, filled with water, and of an oval form, fastened to the omentum; and some in the pelvis between the bladder and rectum. He suspected them to be animals, because they were included in a membrane like a matrix, so loosely, that by opening it with the finger or a knife, the internal bladder, containing the serum or lympha, seemed devoid of any connexion with it, but very readily dropt out, still retaining its liquor without spilling any; and this internal bladder had a neck or white body, more opaque, and protuberant, with an orifice at its extremity; by which, as with a mouth, it exhausted the serum from the external membrane, and so supplied its bladder or stomach. On bringing this neck near the candle, it moved and shortened itself. It is found in the abdomen of sheep, swine, mice, &c. lying between the peritoneum and the intestines.

The *stentorea*, or funnel-like polype, is of three colours, green, blue, and white; but mostly the last. They do not form clusters, but adhere singly by the tail to whatever comes in their way; the anterior end is wider than the posterior; and being round, gives the animal somewhat of a funnel form, though the circle is interrupted by a kind of slit or gap, whose edge is surrounded with numerous little fimbrillæ, which by their motions excite a current of water, that forces into the mouth of the animal the small bodies within its reach. Mr. Trembley saw a great number of animalcules fall into the mouths of these creatures; some of which were let out again at an opening, which he could not described. They can fashion their mouths into several different forms; and they multiply by dividing not transversely nor longitudinally, but diagonally.

The *socialis* are found in clusters; and, when viewed by a microscope, appear like a circle surrounded with crowns, or ciliated heads, tied by small thin tails to a common centre, whence they advance towards the circumference, and then turn like a wheel, occasioning a vortex which brings along with it the food proper for them.

The *anastatica*, or clustering polypes, form a group resembling a cluster, or an open flower, supported by a stem, fixed by its lower extremity to some of the aquatic plants, or extraneous bodies found in the water; the upper extremity is formed into eight or

Polypi & their works.



nine lateral branches, perfectly similar, which have also subordinate branches, whose collected form resembles a leaf. Every assemblage is composed of one principal branch or nerve, which makes with the main stem of the cluster an angle rather larger than a right one; from both sides of this nerve, the smaller lateral branches proceed, and are shorter the nearer their origin is to the principal branch. At the extremity is a polype and others on both sides, but at different distances. They are all exceedingly small, and bell-shaped, with a quick motion about the mouth, though it is impossible to discern the cause of it.

LECTURE XXXIV.

WORMS.

> But let not on thy hook the tortur'd worm,
> Convulsive, twist in agonizing folds;
> Which, by rapacious hunger swallow'd deep,
> Gives, as you tear it from the bleeding breast,
> Of the weak, helpless, uncomplaining wretch,
> Harsh pain and horror to the tender hand.
>
> THOMPSON.

WORMS are totally different from insects, although not seldom so denominated. Their organization is less perfect than that of insects; by much the larger number of the worm-tribe are destitute of ears, nose, eyes, and legs; to which may be added, the slow motion of which many are capable, some being ever fixed to their natal spot; and others, moving only with the substance to which each may happen to be attached; yet each possessing vitality, and hence anciently called *imperfect animals.*

The head, or anterior part, is generally distinguished by tentacula, or feelers, which are retractile, and of the nature of the horns of snails; with these they feel and entangle their prey, and convey it to the mouth or orifice. There is also a heart and vessels to be discerned in most worms, not to be found in polypes. In substance, they are soft and gelatinous, and extremely tenacious of life, so that they can reproduce* any part of which they may be deprived, similar to polypes.

In proceeding through my department of Animated Nature, so very extensive, yet little understood, the attention will be directed first to the objects

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* Reproduction means the restoration of a thing before existing, but destroyed. It is well known that trees and plants may be raised from slips and cuttings; and observations have shown, that some animals have the same property. The polype was the first instance, but we had scarce time to wonder at the discovery Trembley had made, when Bonnet discovered the same property in a species of water-worm.

It deserves inquiry, whether this reproduction will take place in whatever part the worm is cut? Bonnet tried many experiments on the water-worms which have this property. These are, at their common growth, from two to three inches long, and of a brownish colour, with a cast of reddish. From one of these worms he cut off the head and tail, taking from each extremity only a twelfth of an inch, but neither piece was able to reproduce what was wanting. They both perished in about twenty-four hours; the tail first, and then the head. The body still lived as well as before, and seemed to suffer nothing by the loss, the head-part being immediately used as if the head was thereon, boring the creature's way into the mud. In two other points also the reproduction will not take place: one is about the fifth or sixth ring from the head, and the other at the same distance from the tail; and probably owing to the condition of the great artery in these parts.

The want of the reproductive power, relates only to the head and tail ends; for the body feels little inconvenience from the loss, and speedily reproduces those parts. Where, then, is the principle of life in such worms, which, after their heads are cut off, have not only the same motions, but even the inclinations, they had before? And this difficulty is very small, compared to several others which offer themselves. Is this wonderful reproduction of parts only a natural consequence of the laws of motion? or is there lodged in the body of the creature a chain of minute buds or shoots, a sort of little embryos, already formed and placed where the reproductions are to begin? Are these worms mere machines? or are they, like more perfect animals, a sort of compound, whose springs of motion are actuated or regulated by a sort of mind? And if themselves have such a principle, how is this principle multiplied, and found in every separate piece? Is it to be granted, that there are in these worms, not a single mind, (if it be so called,) but that each contains as many as there are pieces capable of reproducing perfect animals? Are we to believe, with Malpighi, that these worms are all heart and brain, from one end to the other? This may be; but, if even we knew this, we should know in reality very little more by knowing it.

The nice sense of feeling in spiders, has been mentioned by naturalists; but these worms have something more surprising, in regard to this particular. When a piece of any substance is brought near recognized solely by the aid of the microscope, and then progressively to the others.

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them, they do not wait for its touching them, but leap and frisk about as soon as it approaches them. The experiments have not ascertained whether this is really owing to feeling or sight; for, though without visible organs of sight, yet they seem affected by the light of the sun, or a candle, and always frisk about when exposed to either; and even the moon-light has some effect upon them.

A twig of willow, poplar, or many other trees, being planted in the earth, takes root, and becomes a tree, whose every piece will in the same manner produce other trees. So will these worms; they are cut into pieces, which become perfect animals; which may be again cut into pieces, each of which will in the same manner produce an animal. Some have supposed that these worms were oviparous: but Bonnet, on cutting one of them to pieces, having observed a slender substance, resembling a small filament, to move at the end of one of the pieces, separated it; and, on examination, it proved to be a perfect worm, of the same form with its parent, which lived and grew larger in a vessel of water into which he put it. These small bodies are easily divided, and readily complete themselves again, a day serving for the re-production of a head, and the small and slender worms sooner complete themselves. The bodies of the large worms, attentively examined by the microscope, exhibit the young worms alive, and moving about within them. The ramifications of the great artery have much the appearance of young worms, and have a sort of continual motion by the systole and diastole of the several portions of the artery, which serve as so many hearts. It is certain, that what by our operations we force in regard to these animals, is done naturally every day in the brooks and ditches, where a curious observer will find many without heads or tails, and some without both; as also other fragments, all then in the act of completing themselves; but, whether accidents have thus reduced them, or they purposely throw off parts of their own body for the reproduction of more animals, it is not easy to determine. They are liable to many accidents, by which they lose parts of their body, and must perish early had they not a power of reproducing what was lost; they often are broken by the resistance of some hard piece of mud which they enter; and they are subject to a kind of gangrene, rotting off the several parts of their bodies, and must inevitably perish but for this surprising property.

But Nature does not seem to have limited her beneficence in this respect to the worm and polype. Bonnet tried the same experiments on another species of water-worm, much thicker, which, when divided in the summer season, often shows the same property; for, if cut into three or four pieces, they lie long like dead, but afterwards move about again; and are found to have recovered in this state of rest a head, or a tail, or both. After recovering their parts, they move very little, and seldom live more than a month. It should seem, that the more difficult success of this last kind of worm, after cutting, and the long time to recover the lost parts, if it do recover them, is owing to its thickness; since in that species of worms

Microscopic Animals.—They are the animalcules of moving bodies in water, in which certain substances

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which succeeds best, those which are thinnest always recover their parts soonest.

The water-insects are not the only creatures possessing this power; the earth affords us some, already discovered to grow in this manner from their cuttings, and these equally deserve our admiration; such are the common earth-worms. Some of these worms have been divided into two, or three, or four pieces; some of which pieces, after being two or three months without any appearance of life or motion, have then begun to reproduce a head or tail, or both. The reproduction of the anus, after such a state of rest, is no long work; a few days will do it; but it is otherwise with the head; that performs its functions in the divided pieces only about seven months after the separation. In all these operations, on both earth and water-worms, in the cutting, the hinder part suffers more than the fore part, for it twists about as if in strong convulsions; whereas the head usually crawls away without the appearance of much uneasiness.

The reproduction of several parts of lobsters, crabs, &c. is also one of the remarkable phenomena in nature. That, instead of an organical part of an animal broken off, another shall rise perfectly like it, may seem inconsistent with the modern system of generation, which supposes the animal to be wholly formed in the egg. Yet has the matter-of-fact been well attested by fishermen, and particularly by Reaumur and Perrault, whose skill and exactness in such things will not be questioned. The legs of lobsters, &c. consist each of five articulations; now, when any leg breaks by accident, as in walking, &c. which frequently happens, the fracture is always near the fourth articulation; and what they thus lose is reproduced after some time, that is, a part of a leg shoots out, consisting of four articulations, the first whereof has two claws as before; so that the loss is entirely repaired. If a lobster's leg be designedly broken off, at the fourth or fifth articulation, reproduction always takes place; but, if the fracture be made in the first, second, or third articulation, the reproduction is very rare, if things continue as they are. But, what is exceedingly surprising, is, that they do not; for, upon visiting in four days, the lobster maimed in these barren and unhappy articulations, all the other articulations are found broken off to the fourth; and it is suspected they have performed the operation on themselves, to make the reproduction of a leg certain. The part reproduced is not only perfectly like that retrenched, but also, in a certain space of time, grows equal to it. Hence we frequently see lobsters with their two big legs unequal, and that in all proportions. This shows the smaller leg to be a new one. A part thus reproduced being broken, there is a second reproduction. The summer, the only season when the lobsters eat, is most favourable for reproduction, which is then performed in four or five weeks; whereas, at any other season, it requires eight or nine months. The small legs, as also the horns, are seldom reproduced, and very slowly. The experiment is mostly with ease tried on the common crab.

have been infused, and of which there are many different kinds. They are sometimes found in water, called pure, but the microscope discovers its minute inhabitants; though not equally in all kinds of water, or in all parts of the same kind. The surfaces of infusions leave generally a scum easily broken, but which thickens by standing. In this the greatest number of animalcules are found. Sometimes it is necessary to dilute the infusions with water, not only distilled, but viewed through a microscope, lest it should have animalcules in it, and thus prove a source of deception. It is most proper to observe those minute objects after the water is a little evaporated; the attention being less diverted by a few objects than by great numbers. Two or three animalcules may be separated by placing a small drop of water on the glass near that of the infusion; join them carefully with a pin; and, as soon as an animalcule has entered the clear drop, cut off the connexion.

The microscopic animals are so different from those of the larger kinds, that little analogy seems to exist between them; and one would almost be tempted to think, they lived by laws directly opposite to those which preserve ourselves and other visible animals in existence.*

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* They have been systematically arranged by Muller, though it is not probable that all the different classes have yet been discovered. Such as have been observed, however, are thus divided:

I. *Devoid of External Organs.*

1. Monas: Punctiforma. A mere point.
2. Proteus: Mutabilis. Mutable.
3. Volvox: Sphæricum. Spherical.
4. Enchelis: Cylindracea. Cylindrical.
5. Vibrio: Elongatum. Long.

* Membranaceous.

6. Cyclidium: Ovale. Oval.
7. Paramecium: Oblongum. Oblong.
8. Kolpoda: Sinuatum. Sinuous.
9. Gonium: Angulatum. With angles.
10. Bursaria. Hollow like a purse.

II. *Having External Organs.*

* Naked, or not inclosed in a shell.

1. Cercaria: Caudatum. With a tail.
2. Trichoda: Crinitum. Hairy.

How many kinds there may be is yet unknown; as they are discerned of all sizes, from those barely invisible to the naked eye, to such as resist the force of the microscope, as the fixed stars do that of the telescope, and with the greatest powers hitherto invented, appear only as so many moving points. The smallest living creatures our instruments can shew, inhabit the waters; for though animalcula equally minute may fly in the air, or creep upon the earth, it is scarce possible to get a view of them; but as water is transparent, by confining the creatures within it we can easily observe them by applying a drop of it to the glasses.

Animalcules move in all directions with equal ease and rapidity; obliquely, strait forward, in a circular direction, or rolling upon each other, running backwards and forwards through the whole extent of the drop, as if diverting themselves; at other times greedily attacking the little parcels of matter they meet with. Notwithstanding their extreme minuteness, they avoid obstacles, and prevent any interference with another in their motions: sometimes they suddenly change their direction, and take an opposite one; and, by inclining the glass on which the drop of water is, so the animalcules appear to move as easily against the stream as with it. When the water begins to evaporate, they flock towards the place where the fluid is, and show great anxiety, and uncommon agitation of the organs with which they draw in the water. These motions grow languid as the water fails, and at last cease altogether, without a possibility of renewal, if they be left dry a short time. They sustain a great degree of cold as well as insects, and will perish in much the same degree of heat that destroys insects. Some animalcules are produced in water at the freezing point, and some insects live in snow.—By mixing the least drop of urine with the water in which they swim, they instantly fall into convulsions and die.

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3. Kerona: Corniculatum. With horns.
4. Himantopus: Cirratum. Cirrated.
5. Leucophra: Ciliatum undique. Every part ciliated.
6. Vorticella: Ciliatum apice. The apex ciliated.

* Covered with a shell.

Brachionus: Ciliatum apice. The apex ciliated.

The rule observable in the larger animals seems to hold good in those minute creatures, that the larger kinds are less numerous than the smaller, while the smallest are in such multitudes, that there seem myriads for one of the others. They increase in size, like other animals, from their birth until they have attained their full growth; and when deprived of proper nourishment, they in like manner grow thin and perish.

Their modes of propagation are various, and extremely curious. Some multiply by a transverse division; and though, in general, they avoid one another, yet when one is nearly divided, another pushes itself upon the small neck which joins the two bodies to accelerate the separation.—Others, when about to multiply, fix themselves to the bottom of the water; then becoming first oblong, and afterwards round, turn rapidly as on a centre, perpetually varying the direction of their rotatory motion. In a little time, two lines, forming a cross, are perceived; after which, the spherule divides into four, which grow, and are again divided. A third kind multiply by a longitudinal division, which in some begins in the fore-part, in others in the hind-part; from others a small fragment detaches itself, which soon assumes the shape of the parent animalcule; and, lastly, others propagate in the same manner as the more perfect animals.

The *Hair-like Animalcule*, so called from its shape, first discovered in a ditch at Norwich, by Mr. Baker, is extremely slender, and often an hundred and fifty times as long as broad. The body or middle-part, nearly straight, appears, in some, composed of such rings as the wind-pipe of land-animals; but, in others, rather scaled, or made of rings that obliquely cross each other. Its two ends are hooked or bent in the same degree, but in an opposite direction; and as no eyes can be discerned, it is difficult to ascertain the head or tail. Its progressive motion is by turning upon one end as a centre, and describing almost a quarter of a circle with the other. Its motions are very slow, and require much patience and attention in the observer. These creatures are so small, that millions might be contained in a square inch. Viewed singly they are exceedingly transparent, and of a beautiful green colour; but, when numbers are brought together, they become opaque, lose their green colour, and seem entirely black. Notwithstanding their extreme minuteness, they seem fond of society; for, after viewing for some time a parcel of them taken up at random, they will be seen disposing themselves in a kind of regular order. If a multitude are put into a jar of water, they will form themselves into a regular body, and perform a variety of movements and evolutions, like those of an army.

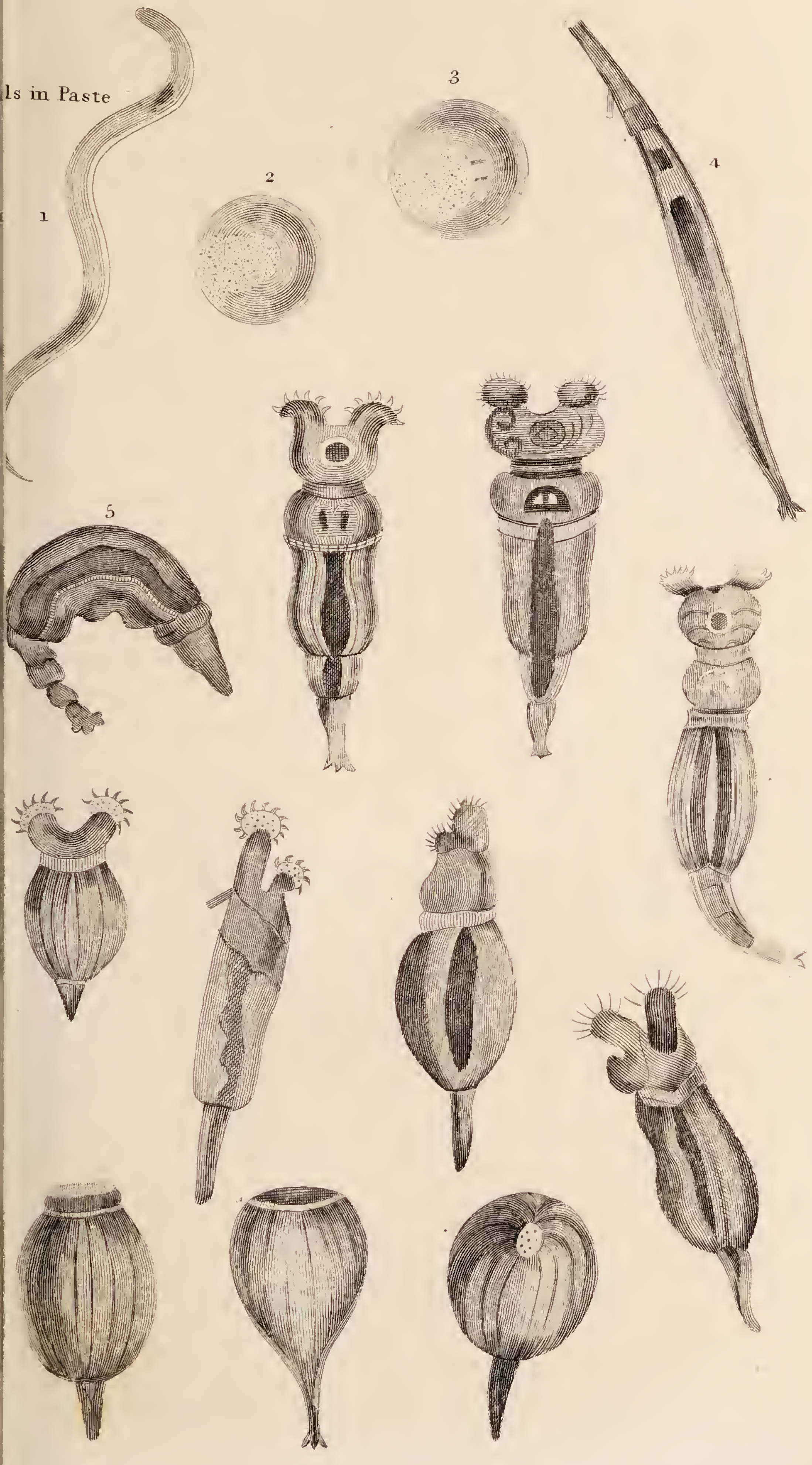
Eels in paste are obtained by boiling a little flour and water into the consistence of book-binder's paste; then exposing it to the air in an open vessel, and beating it frequently together to keep the surface from growing mouldy or hard. In a few days it will be peopled with myriads of little animals visible to the naked eye, which are the eels in question. They may be preserved a-year by keeping the paste moistened with water, and the motion of the animals will keep the surface from mould; a drop or two of vinegar may be put into the paste now and then. When they are applied to the microscope, the paste must be diluted in water for them to swim in. And though their form cannot be perfectly distinguished, their motion is very perceptible. The most remarkable property of these insects is, that they are viviparous. If one of them is cut through near the middle, several oval bodies of different sizes will be seen to issue forth. These are young, each coiled and enclosed in its proper membrane, so exquisitely fine, as scarcely discernible by the greatest magnifier, while it encloses the embryo animal. The largest and most forward immediately break through this covering, unfold themselves, and wriggle nimbly about in the water; others get out, uncoil, and move themselves more slowly; and the least mature continue oval without motion. The *uterus*, or vessel that contains these bodies, is composed of many ringlets, resembling the aspera arteria of land-animals, and seems considerably elastic; for as soon as the animalcule is cut in two, the oval bodies are thrust out with some violence, from the springing back or action of this bowel. Upwards of an hundred young ones have been seen issuing from the body of one single eel; hence their prodigious increase, as probably several such numerous generations are produced in a short time. These eels being viviparous, renders it highly improbable that they ever become flies. Similar animalcules are found in vinegar; and also in the soft fibrous matter of those grains of blighted wheat, that appear black as if scorched.

The *Proteus* was so named by Mr. Baker, from its assuming numerous different shapes, so as scarcely to be known as the same animal; and, indeed, unless carefully watched while passing from one shape to another, it will often become suddenly invisible.

When water, wherein any sort of vegetable has been infused, or animals preserved, has stood some days or weeks, in any glass, or other vessel, a slimy substance will be collected about the sides; some of which being taken up with the point of a penknife, and placed on a slip of glass in a drop of water, and viewed through the microscope, will be found to harbour several kinds of little animals, seldom found swimming about at large; among which the proteus is one. Its substance and colour resemble that of a snail; and its general shape that of a swan. It swims to and fro with great vivacity; but will now and then stop for a minute or two; during which, its long neck is usually employed, as far as it can reach, forwards, and on every side, with a somewhat slow, but equable motion, like that of a snake, frequently extending thrice the length of its body, seemingly in search of food. It has no eyes nor mouth discernible, but its actions prove that it can see; for, though multitudes of different animalcules swim about in the same water, and its own progressive motion is very swift, it never strikes any of them, but dexterously directs its course between them. When alarmed, it suddenly draws in its long neck, transforms itself, becomes more opaque, and moves about very slowly, with the large end foremost. It will then, perhaps, instead of the head and neck it had formerly, put forth a new one, with a kind of wheel-machinery, whose motions draw a current of water to it from a considerable distance. Having often pulled in and thrust out this short head, either with, or without the wheelwork, the creature, as if weary, will remain motionless awhile; then its head and long neck will be again very slowly protruded, and it resumes its former agility.

The *Vorticella, or Wheel-animal*, is found in rain water, that has stood some days in leaden gutters, or in hollows of lead on the tops of houses, or in the sediment left by such water. Though it discovers signs of life only when in the water, yet it will continue alive many months in a dry state, of a globular shape, and not the size of a grain of sand. On being put into water, in half an hour a languid motion begins, the globule turns itself about, lengthens by slow degrees, assumes the form of a lively maggot, and mostly in a few minutes afterwards, puts out its wheels; swimming vigorously through the water, as if in search of food; or else, fixing itself by the tail, so works the wheels as to bring its food to it The most remarkable thing in the structure of this animalcule is its wheel-work; which consists of a couple of semicircular instruments, round whose edges many little fibrillæ move very briskly, in either a rotatory, or a trembling, or vibrating manner. At the least touch, or motion in the water, they draw in these wheels, conjectured to contain their eyes, because, while in the maggot state, its motions are slow and blundering; but, after the wheels are protruded, they are performed with great regularity and swiftness. The transparency of its body allows its internal parts to be seen. In the appearance of the head, though every where transparent, a ring or circle, more particularly remarkable for its clearness, is commonly perceived about the middle of the forehead, a little above the mouth; which, Mr. Baker thinks, is the seat of the brain. The thorax is joined to the head by a very short neck, and appears to be about the sixth part of the whole length of the animal. In the middle of the thorax is the heart, where its systole and diastole are plainly visible through the insect's back. Its blood, or circulating fluid, is so absolutely colourless, that the current is indistinguishable. A sort of irregular agitation of some fluid is indeed perceived, perhaps a compound motion of currents running different ways, and form-

Various forms of Animalculæ or Wheel Insects.



ing such an appearance, though no single current is visible. From the under part of the thorax proceeds a small transparent horn, only visible when the animal turns itself. Immediately below the thorax is another annular division, joining the thorax to the abdomen, by much the largest part of the animal, and contains the stomach and intestines. When the insect is full of food, these bowels appear opaque and of a blood-red colour, extending through the belly and much of the tail, exhibiting various contractions and dilations. The belly is capable of much expansion or contraction. It assumes many shapes, and becomes occasionally a case for all the other parts of the body.

There are found in stagnant waters several other species of animalcules, furnished with wheels, some of which appear to have a rotatory, and others a vibratory motion. Some kinds of wheel-animals are also covered with shells; the body consisting of three parts. These occasionally draw themselves entirely within their shell, which then appears terminated by six short spikes on one side, and two on the other. The young ones of this species are carried in oval integuments, fastened externally to the lower part of the shell about the tail. When a young one is about to burst its integuments, the parent assists it by wagging its tail, and striking the oval bag, so as to force the young one's head into the water, though the tail cannot be so disengaged. In this condition the young one sets its wheel a-going and exerts all its endeavours to escape from its confinement. When it has got clear, it swims away, wagging its tail as the old one does, and leaving the integuments adhering to the shell of the parent, who uses many efforts to get rid of it.

The Bell-flower Animals or Plumed Polypes, dwells in colonies, from ten to fifteen, in a slimy mucilaginous or gelatinous case; which out of the water, has no determined form, appearing like a little lump of slime; but, when expanded therein, resembles the figure of a bell with its mouth upwards; and is usually about half an inch long, and a quarter of an inch in diameter. These bells, or colonies, are found adhering to the large leaves of duckweed, and other aquatic plants. They may be easily discovered, by putting a quantity of water, with duckweed, to stand three or four hours in glass vessels in a window, or other place where is a strong light; when, if any are about the duckweed, they will extend themselves out of their cases, and make an elegant appearance. The bell, or case, seems divided internally into several small sacculi, in each of which is one of these animals; being very transparent, all the motions of its inhabitants may be discerned through it. The openings at the tops of these sacculi, are sufficient for the creature's head and a small part of its body to be thrust out, the rest remaining always in the case. It can however retire into its case altogether; and always does so, when alarmed by any sudden motion of the water. Besides the particular and separate motion which each of those creatures can exert within its own cause, independent of the others, the whole colony has a power of altering the position of the bell, or even of removing it to another place; and hence the bell is sometimes found upright, and at other times bending the open part downwards. As they seem not to stay together in societies whose number exceeds 15, when the colony exceeds that number, the bell may be observed to split gradually about the middle of the anterior extremity, and proceeding downwards towards the bottom, till the parts separate, and become two complete colonies, one of which sometimes removes to another part of the vessel.

The arms of each individual, to the number of 40, are set round the head, having the figure of an Italic *s*, one hooked end being fastened to the head; and when expanded altogether, compose a figure somewhat like a horse's shoe, convex on one side next the body, but gradually opening outwards, so as to leave a considerable area within the outer extremities of the arms. When the arms are extended, the creature, by a vibratory motion, can produce a current in the water, which brings all minute bodies within the sphere of its action, with great velocity to its mouth, situated between the arms; where they are devoured if liked or driven away by a contrary motion. The body consists of three divisions; the uppermost contains the intestines. The other two are probably fixed to the bell, and give the creature a power of contraction and extension. Though their general appearance, when expanded, is that of a cup whose base and top are of an horse-shoe form, they sometimes separate into four parts, and range themselves so as to resemble four separate plumes of feathers. Though their eyes cannot be discovered, yet when kept in the dark, their arms remain contracted; but, on being exposed to the light of the sun, or of a candle, they constantly extend them, and evince signs of pleasure.

The Pipe animals, are found on the coast of Norfolk, in small sandy tubes, or cases, in such multitudes as compose a mass, sometimes three feet in length. The pipe or case is made of sand, intermixed with minute shells, and cemented by a glutinous slime, probably issuing from the animal's own body, which is composed of muscular rinklets like those of a worm, capable of great extension and contraction. The anterior end or head, is exceedingly beautiful, having round it a double row of little arms, disposed very regularly and probably capable of extension, to catch its food, and bring it to its mouth. Some of these tubes are found petrified, and constitute one species of syringoides.

An Insect with net-like arms, whose properties and shape are very extraordinary, is found only in cascades where the water runs very swift, in clusters, standing erect on their tails; and resembling the combs of bees, filled with their aurellæ. On being taken out of the water they spin threads, by which they hang exactly like the garden-spider. The insect's body magnified, appears curiously turned, as in a lathe; and at the tail are three sharp spines, on which it raises itself, and stands upright in the water. But the most curious apparatus, is about its head, furnished with two fans or nets, to provide its food. These it frequently spreads out and draws in again; and when drawn up they are folded close to the body with the utmost nicety and exactness, so as to be indiscernible. At the bottom of these fans are a couple of claws fastened to the lower part of the head, which, when the nets are drawn in, conduct to the mouth whatever is taken. When the creature does not employ its nets, it thrusts out a pair of sharp horns. Some of these creatures being kept with water in a vial, most of them died in two days; and the rest, having spun themselves transparent cases fastened either to the sides of the glass, or to pieces of grass, the water seemed changed into a kind of chrysalis. But before taking this form, they appeared the shape they assume when weary with catching their food, or when lying in wait for it. None of them lived above three days; and though fresh water was given to them twice or thrice a day, yet in a few hours it would stink to a degree scarcely conceivable; hence it is probably necessary for them to live in a rapid stream, lest they should be poisoned by the effluvia from their own bodies.

Numberless animalcules are observed in infusions of pepper. To make an infusion for this purpose, bruise as much common black pepper as will cover the bottom of an open jar, and lay it thereon about half an inch thick: pour soft water into the vessel about an inch above the pepper. Shake the whole well together; after which they must not be stirred, but exposed to the air a few days; when a thin pellicle will be formed on the surface, in which innumerable animals may be observed by the microscope.

Animalcula Infusoria, take their name from being found in all kinds of either vegetable or animal infusions. Indeed almost every kind of water discovers living creatures. Lewenhoek says, that, at first he could discern no living creatures in rain-water; but after standing some days, he discovered innumerable animalcules, many thousand times less than a grain of sand, and in proportion to a mite, as a bee is to a horse. In other rain-water, which had likewise stood some time, he found the smallest sort he had ever seen; and in a few days more, met with others eight times as large and almost round. In another quantity of rain-water, exposed like the former, he discovered a kind of animalcules with two little horns in continual motion; The space between the horns was flat, though the body was roundish, tapering a little towards the tail, which was four times as long as the body, and as thick as a spider's web. He observed several hundreds within the space a grain of sand would occupy. If they happened on the least filament, they were entangled in it; and would then extend their bodies into an oblong round, and struggle hard to disengage their tails. He observed a second sort, of an oval figure, and imagined the head to stand at the sharpest end. The body was flat, with several small feet moving exceedingly quick, but not discernible without much attention. Sometimes they became spherical, especially when the water began to evaporate. He met also with a third sort, twice as long as broad, and eight times smaller than the first; yet with feet, whereby they moved very nimbly. He perceived likewise a fourth sort, a thousand times smaller than a gnat's eye, and which exceeded all in briskness: turning themselves round, as upon a point with the celerity of a top.

The *Pitcher-shaped Branched Worm*, is found in clear stagnant water, just visible, like a lucid speck. When magnified, it appears bell-shaped, of a greenish-yellow, long tail with the tip bifid; the shell toothed at the top and rounded at the base; the head is furnished with double rotatory organs, which can be protruded or concealed. The economy of this little animal, may elucidate that of the *Infusoria* tribes. It consists of a head, thorax, and abdomen, each expansive and contractile; and, when all are dilated, the head protrudes beyond the shell, as, when contracted, the whole body is within it. The head, when completely extended, divides the two rotatory branches, between which comes out a kind of proboscis, armed with two sets of fibrils, at rest, resembling a broad point; but which can be moved to and fro with a brisk vibratory motion. The ends of these branches are sometimes round, and the motion rotatory. The thorax joins the lower part of the head; it is muscular, within is a moving intestine, supposed analogous to the lungs or heart. The thorax communicates with the abdomen, by a short vessel, whose alternate contractions and dilatations occasion the abdomen to rise and fall, accompanied by a kind of peristaltic motion. By this also, food is conveyed into the abdomen, whence after digestion it is discharged by the anus, near the tail. The tail is strengthened by three articulations, and divided at the extremity, the better to fasten to objects; it projects from the lower extremity of the shell, moving nimbly, and serving as a rudder when the animal swims; and when attached to any firm substance, the animal fully enjoys its curious rotatory motion. When the animal composes itself to rest, it contracts down into the shell the head and fore part of the body, and pulls the tail upward, the whole into the shell; which is so transparent that the termination of the edges cannot be easily distinguished; but what occurs within the shell, is as plain as if there were no substance between the eye and the interior parts. It is wonderful to see the young, scarcely loosened from their bag, set their little rotatory wheels in motion, and appear with all the activity and instinct of the parent worm.

LECTURE XXXV.

THE EARTHWORM.

This object of animation is very common. The body is cylindrical, annulated, with an elevated fleshy belt near the middle, mostly rough, with concealed minute longitudinal prickles, and a vent-hole in its side. There are two species. 1. the earth or dew-worm, Lumbricus *terrestris*, which differs much in colour and appearance at different periods of its growth; hence, people little acquainted with such variations of animals, make four or five different species of worms. The general colour is a dusky red. They live in decayed wood, which, by being perforated, is fitter to receive the rain. They quit the earth only after heavy rains or at the approach of storms, and in the season of their amours; but their wanderings are mostly nocturnal. The method to force them out is, either to water the ground with infusions of bitter plants, or to trample on it. The motion on the surface of the soil drives them up, in fear of being surprised by their formidable enemy the mole. They are also devoured by hedge-hogs, and many kinds of birds. The body when expanded is convex on each side, and when contracted is flattish beneath, with a red canal down the whole body; and its winding progression is facilitated by the inequalities of its body, on which are about 140 rings, each armed with four pair of small, stiff, sharp-pointed bristles: when it means to insinuate itself into the earth, there oozes from its body a clammy liquor, by which it slides down. It seldom damages the roots of vegetables. Its food is a small portion of earth, which it has the faculty of digesting. 2. The *marinus*, marine worm, or lug, is of a pale red colour; the body is composed of a number of sound annular joints, the back has two rows of bristly tubercles, the skin is scabrous, and all the rings or joints are covered with little prominences, which render it extremely rough to the touch. It inhabits the mud about the sea shores, where it buries itself deep in the earth, leaving a little rising with an aperture on the surface, and serving for food to many kinds of fish: surprisingly large ones are to be met with about the Bognor rocks in Sussex. The fishermen bait their hooks and nets with it.

INTERNAL WORMS.

This Class includes the various kinds which infest the bodies of animals, human, domestic, and wild; the last most of all; the gnawing class, less, and the ruminant still less, but in swine the least. There are several kinds.

The Mawor Thread Worm (Ascaris). The body of the ascaris is cylindrical filiform, and taper at both ends. The species are two, *viz.* 1. The maw-worm *(vermicularis,)* with faint annular rugæ, and the mouth transverse, about a quarter of an inch long, and thicker at one end than the other. They are found in boggy places, in the roots of putrid plants, and very frequently in the rectum of children and horses. The skin at the sides is very finely wrinkled; and, as they exist in greatest excess in children, it has been inferred that their ceaseless irritating action on the interior membranes may promote the peristaltic motion of the intestines, by which the fæces are pressed down and excluded, and the passages of the body kept open; which is so essential to health. Yet they emaciate children greatly, and are sometimes vomited up. Their proper nidus is in the slime which lubricates the bowels, that serves them for food, yet preserves them unhurt, though surrounded by many fluids whose touch would be fatal; and by this slime they are in general so well defended from the immediate action of whatever passes the intestines, that they are rarely incommoded in their nidus, unless they exist in great numbers. The male and female are distinct worms; the male, when magnified, has not the gyrated apparatus, which, in the female, is certainly to perfect the young. The stomach and intestinal canal differ in arrangement in the sexes, and are the only viscera observed. The generative organs have eluded discovery. About the eighth of an inch from the head of the female, is a small aperture for protruding the young; upwards of a hundred having been observed to escape, alive, and very vivacious, several hours after the death of the mother. When much magnified, the internal cavity appears filled with the convoluted apparatus.

The *large Maw-Worm (lumbricoides)* is about the same length with the common earth-worm; but it wants the protuberant ring towards the middle of the body, the chief mark by which they can properly be distinguished. The body of the lumbricoides is cylindrical, and subulated at each extremity; the head has three vesicles, and is slightly incurved, with a transverse contraction, the mouth is triangular, as is also the tail. The colour is a pale yellow, the muscles very delicate, with a longitudinal line very distinctly marked. The lumbricoides is the worm which is most commonly found in the human intestines. It is viviparous, and produces vast numbers. When recently excluded, they are transparent, and appear as if they had been sucking water tinged with blood; this colour, however, soon disappears, and they become yellowish. Their motion is serpentine, but soon becomes feeble, and they quickly die on exposure to the air.

A species, found in horses, is often 18 inches long, and half an inch thick, of a pale bluish colour, often with large brown patches.

The *Blunt Head (Tricocephalus)* is seldom found in England. The body is round, and very curiously wrinkled; the head or fore part is much the thickest, furnished with a slender exsertile proboscis, which is expansive and contractile at pleasure. The stomach and intestines consist of a long greenish canal, which is continued in a straight tube the whole length of the animal, and terminated in the anus.

The *Guinea-Worm (Filaria)*, inhabits both Indies. The body is round, filiform, equal, and quite smooth; the mouth dilated, with a roundish concave lip. This worm is frequent in the morning dew, from whence it forms a lodgment in the cellular membranes under the cuticle, or scarfskin; or it insinuates itself under the cuticle of the naked feet of the slaves, and creates the most troublesome itchings, sometimes accompanied with inflammation and fever: the author has known it to yield to olive oil dropped on the part; but in general it must be cautiously drawn out by a silk thread, or strong horsehair, tied round its head; for, if strained so as to break, the part left under the skin grows with redoubled vigour, and has been known to occasion a fatal inflammation. It has been found 12 feet long, though no thicker than a horse-hair.

There is a species found under the skin of larvæ, and very destructive to them, from 4 to 7 inches long; body glabrous, hard, tapering both ways, but more obtuse on the fore part, defended with three oblong lips.

The *Fish Worm (Scolex)*. The body is gelatinous, variously shaped, broadish on the fore part, and pointed behind; sometimes linear and long, or wrinkled and short, round, flexuous or depressed; the head is prutrusile and retractile, with 4 auricles. The animal is most minute, and, in its contracted state, needs to be ascertained by the microscope; it is a very vivacious little creature, and possesses the faculty of assuming numerous different shapes and sizes.

The *Bandage Worm (Ligula)*. The body is clear white, linear, equal, long and very narrow, the forepart obtuse; the hind-part acute, with an impressed dorsal suture; and resembles tape. They are found in fish, and make them grow deformed; when they escape from the body they penetrate the skin. They are about half a line thick, and from 6 inches to 5 feet long.

The *Swine Scratcher* does not infest the human subject; but may be found fixed firmly to the viscera of various animals, generally the intestines, often on the same spot during the whole life of the animal; especially in the intestines of swine that have been fattened in styes. The body is round, of a white colour; the proboscis cylindrical and retractile in a sheath and crowned with numerous rows of hooked prickles. It is gregarious, and from 12 to 18 inches long. The largest variety is found in the boar.

The *Hooded Worm*, so called because the head is surrounded with a kind of striate hood; is mostly viviparous, the body sharp, spirally convalved, pointed behind, and obtuse before.

The *Fiend (Furia)* has a linear smooth body, ciliated on each side, with reflexed feelers pressed to its body. In Finland, Bothnia, and the northern provinces of Sweden, it inhabits the vast marshy plains, where it crawls up shrubs and sage grass: and, being carried forwards by the wind, it falls in different places, and penetrates suddenly into any exposed parts of men and horses, not perpendicularly situated. It quickly insinuates itself under the skin, leaving a black print where it had entered, which soon causes the most excruciating pain, inflammation, and gangrene of the part; and, sometimes, swooning and death happen in the course of a day or two, and even in a few hours, unless the worm is immediately extracted. It was not unfrequently that people were seized with a pungent pain, confined to a point, in the hand or other exposed part of the body, which presently increased to a most excruciating degree, and even sometimes proved suddenly fatal. This disorder was more particularly observed in autumn, about boggy and marshy places. At length it was discovered that this pain instantly succeeded something that dropped out of the air, and in a moment penetrated and buried itself in the flesh. The Finlanders tried a variety of applications to no purpose, until a poultice of curds or cheese was found most effectual in easing the pain; and the event discovered that the insect was allured by this application to leave the flesh; as, on its removal, this worm, no longer than the sixth of an inch, was found in it, and thus the cause of this painful disease appeared.

The *Hair Worm (Gordius)*, from its numerous and nimble contortions. There are several species: 1. The *aquaticus*, or water hair-worm, is 10 or 12 inches in length, and of about the thickness of a horse-hair: its skin is smooth and somewhat glossy, without furrows: its colour pale yellowish-white all over, except the head and tail, which are black and glossy. The body is of a pale brown, with dark extremities, rounded, filiform, smooth, and very slender in proportion to its length: the mouth is small, and placed horizontally; the jaws are both of the same length, and obtuse at their extremities. It is mostly from 4 to 6 inches long, twists itself wonderfully, and, if incautiously handled, will inflict a bite at the end of the fingers, and cause the effect called a *whitlow*. This species is common in our fresh waters, more especially in clay, through which it passes as a fish does through the water, and is the author of many springs. This is the worm that, in Guinea, and in some other of the hot countries, gets into the flesh of the natives, and occasions great mischief: with us, though frequent enough in water where people bathe, it never attempts this.—2. The *argillaceous*, or clay hair-worm, is only a variation of the preceding one in colour, being yellowish at the extremities. It chiefly inhabits the clay; and Linnæus calls that its proper element, from its being generally dug out of it.—3. The *marinus* or sea hair-worm is filiform, twisted spirally and lying flat, about half an inch in length; of a whitish colour, smooth, and scarcely diminishing at the head. It is as great a tormentor of herrings, bleaks, and various other fish, as the *gordius medinensis* is of man. The fish when infested with these animals rise to the surface, and tumble about as if in great agony. The length is so various that it may be found from 2 to 35 feet. If the animal be either wounded or divided in body, small threads of milky appearance issue from the parts, that do not mix with the water until it be agitated. The expansion and contraction are so unlimited, that it is scarcely possible to ascertain the utmost length: one supposed to be about 8 feet long, being put alive into spirits, instantly contracted to about 1 foot, at the same time that it increased to double the bulk, primarily the diameter of a crow-quill. In the vast exertions of the muscles, the animal is generally divided where it had been twined into knots.

The *Fluke (fasciola)*, or gourd worm: the body is flattish, and has a vent hole at the head or extremity, and one on the belly. There are several species. 1. The *hepatica*, sleep-worm, or liver-fluke, grows to two thirds of an inch in length, though it is met with not half that size; and its breadth is nearly equal to two-thirds of its length. In form it bears some resemblance to the seed of the gourd, whence its trivial name; and its likeness, in miniature, to our common flat fish, gained it that of fluke, or flounder; it is flattish, but a little rounded on the back, which is yellowish, and has about eight deep longitudinal furrows in two series; its skin on the belly is soft and whitish, with a tinge of brown. The hinder part is rounded, the fore part is furnished with a large mouth. It cannot endure cold; but, if deprived of motion thereby, it quickly revives on being held in the hand, or cast into warm liquor. It is found in fresh waters, in ditches, at the roots of stones, sometimes in the intestines, and often in the substance of the other viscera, in quadrupeds. Its motion, when taken from a diseased liver, and thrown into warm water, is vigorous and undulating, much like the fish above mentioned. It often infests the liver of sheep, and causes the disease called the rot; and on that account is called *hepatica*. Bags with salt in them should be placed in the fold, that the sheep might lick them, which is a good remedy.* 2. The *Intestinalis*, or intestinal flüke, is of a long slender form, if extended; when contracted, of a suboval form; inhabits the intestines of fresh-water fish, especially the bream. 3. The *barbata* is white, with tranverse papillæ in the mouth. It is of an oblong shape, and about the size of a cucumber-seed. It is found in the intestines of the sepia lotigo.

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* Leuwenhoek subjected one of these worms to microscopic inspection, and observed the skin on the back rough and furrowed, covered with prickles, and so transparent that the intestines were seen. The head is pointed, the mouth protrudes, of an oval shape, open like a carp's. From the heart, two separate vessels spread over the body and down the back; between which are many so minute that no moisture was discoverable in them. In the larger vessels were juices of a yellowish-brown, purple, and pale green, of a glutinous nature, yet flowing (even after death) towards the heart when the tail was lifted, and back again, when the head is raised. The excretory duct is on the right side of the body, under the head; and the intestines seem as if crowded in a heap. A small protuberance, or liver, is at the beginning of the bowels, and between them are innumerable ovaria, hundreds of which do not equal a grain of sand. They do not present marks of sexuality. In the

HYDATIDS

Are round or globular, and from the size of a grain of sand, to the bulk of an orange. Being of a vesicular form, shaped like small aqueous bladders, and devoid of visible animation, their appearance was long regarded as a species of *Tumour*. They are however now known to possess vitality, and be capable at certain times, of detaching themselves from their situations. Their contexture is membranaceous, firm, and of a red colour: the head is furnished with a kind of tube; also with four suckers, so placed as to divide it equally into four parts; and a double series of hooks, to hold in their situation, whose acute points all turn towards the neck, the first exceeding the second series in size. The four divisions have an elevated margin, perforated to form the mouths, from which four canals pass parallel along the neck and body, but soon become so pellucid, that the microscope cannot detect them. They are generally superficial, some portion being enveloped, the other rising above the fat, liver, spleen, uterus, lungs, or other part, where they form a cist of cartilaginous firmness, composed of different laminæ. Their size is varied with their age, and the temperament of their habitation; and their figure mostly spherical, a little flattened; in the part opposite the head, is a disc rather thicker than the membrane, with many fat-tubercles, supposed to be eggs; they are partly filled with lymph, of an oily salt taste. They differ from the tape-worm in expansion and habitation. Preparations of mercury are supposed to be the only certain remedies for these very troublesome creatures.

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liver of some sheep they swarm; in others scarce a dozen are observed. The tubercles are to attach itself to the different parts of the body.

THE TAPE WORM

Has its name from its resemblance to tape in flatness, and almost incredible length; some having been voided from 15 to 50 feet long. The body is slender, depressed, and jointed like a chain; and each joint has a mouth and viscera.

Three species of this worm are incident to man: the *lata*, *vulgaris*, and *solium*. The *lata*, found in Switzerland and Russia, is white, with joints very short, and knotty in the middle; the osculum is solitary, the ovarum disposed like the petals of a rose, the joints streaked transversely, and from 18 to 120 feet in length. The *vulgaris*, or common tape-worm, having two lateral mouths in each joint, attaches itself so firmly to the intestines, that it is with difficulty removed by the most violent medicines; it is slender, and appears membranaceous, rather pellucid, from 6 to 16 feet long, and at one end above four lines broad. The *solium* has its name from the erroneous supposition, that only one of the species inhabits the same individual at the same time; whereas several have been voided by the same patient in very short intervals. It has a marginal mouth on each joint.

As the tænia is often the occasion of disease, we may be apt to consider it, not only useless, but even hurtful; yet it is irrational to suppose that the Benevolent Father of mankind created a species of animals solely to produce disease. The creation of the tænia is rather a striking instance of that rule of Deity, to leave no place destitute of living creatures where they could multiply their species. He has, therefore, not only covered the earth with animals, but the surface of animals with others; and has even peopled those internal parts which could supply nourishment without disadvantage. Perhaps, therefore, a certain proportion of these animals is conducive to health, as is a certain proportion of different fluids; while excess always produces disease. For, in almost every different species of quadrupeds, is a different species of tænia, which is a full proof that these worms have their structure and situation determined with as much attention and skill, as any other species of animals. Those species of tænia peculiar to the human race, are also peculiar to particular countries; thus, the vulgaris is most common in Sweden, the lata in Switzerland and Russia, and the solium in Great Britain, Saxony, and Holland.

The tænia, destined to feed upon those juices of animals already animalized, is mostly found in the alimentary canal, and in the upper part, where is most chyle; for chyle seems its natural food. Thus supported by food already digested, it is destitute of digestive organs. As the tænia solium is most frequent in this country, it may be proper to describe it more particularly. It is from 3 to 60 feet long. It is composed of a head, having a mouth adapted to drink fluids, and an apparatus to give the head a fixed situation. The body is composed of many distinct pieces articulated, each joint having an organ whereby it attaches itself to the neighbouring part of the inner coat of the intestine. The joints near the head are always small, and gradually enlarge, but a few of the last joints again diminish in size; the extremity is terminated by a small semi-circular joint, without opening. The head, placed at the smallest extremity, is of the same materials as the other parts; a rounded opening is considered its mouth, united to a chain of articulations, each having its proper viscera, which enlarge gradually, and terminate in a tail or round joint. When viewed by the naked eye, the worm laid flat presents three projections, one anterior, and two lateral; but, if the head be held up, and its extremity attentively viewed, five projections appear, one anterior in the middle, the proboscis; and four backwards and lateral. The opening, or mouth, is continued by a short duct into two canals, which pass round every joint, and convey the aliment. Round the opening of the mouth are a number of radii projecting longitudinally, of a fibrous texture, which serve the purpose of tentacula for fixing the orifice, and of muscles to expand the cavity of the mouth. The neck of the proboscis, on approaching its basis, becomes flat and broad; its basis is quadrangular, with a hollow protruding tubercle, or osculum, at each angle; it then forms a thick margin, which receives the adjacent margin of the next joint. The joints are shortest near the head, and their length towards the tail is sometimes less than their breadth. The joint next the head is received into the basis of the head, and in like manner it receives the beginning of the next joint; and so through all the extent of the worm. After the rounded extremity or head has been narrowed into the neck, the lower part becomes flatted, having on each side two small tubercles, concave in the middle, and serving the purpose of suckers for attaching the head more effectually. The internal structure of the joints is partly vascular and partly cellular; the substance white, resembling in texture the coagulated lymph of human blood. The alimentary canal passes along each side of the animal, sending over the bottom of each joint a cross canal, which connects the two lateral canals.

Mr. Carlisle with a coloured size, by a single push of a small syringe, injected, three feet in length of these canals, in the direction from the mouth downwards. He tried the injection the contrary way, but it seemed stopped by valves. The alimentary canal impervious at the extreme joint, terminates without any opening analogous to an anus. Each joint has a vascular joint occupying the middle part, composed of a longitudinal canal, whence many lateral canals, containing a fluid like milk, branch off at right angles.

The tænia seems one of the most simple vascular animals in nature. Its mode of nourishment is singular; the food taken in by the mouth passes into the alimentary canal, and thus visits in a general way the different parts of the animal. Not having excretory ducts, the whole of its alimentary fluid seems fit for nourishment; the decayed parts probably dissolve into a fluid, which transudes through the skin, which is extremely porous.

This animal seems to have no organs of sense, except of touch. It is probably propagated by ova, that easily pass along the circulating vessels of other animals.*

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* We cannot explain the phenomena of worms being found in the eggs of fowls, and in the intestines of a fœtus before birth, otherwise than by supposing their ova, to have passed through the

The chance of an ovum being placed in a situation where it will be hatched, and the young find convenient subsistence, must be very small; hence the reason for their being very prolific. Had they the same productive powers which they possess, and were their ova afterwards readily hatched, their multiplication would be immense, and become a nuisance to the other parts of creation.

Another mode of increase of tænia is addition to the number of joints. Considering the individual joints as distinct beings, it is so; and the power of generation in each joint makes this conjecture the more probable. We can hardly suppose an ovum of a tænia at its full growth (30 feet long), and having 400 joints, contained a young tænia composed of this number of pieces; but young tænia, not half a foot long, and not possessed of fifty joints, were still entire worms. When a part of this animal is broken off, it is capable of forming a head for itself, and becomes independent. The simple construction of the head makes its regeneration more easy than that of the tails and feet of lizards, composed of bones and complicated vessels; but this last has been proved by Spallanzani and other naturalists.

When intestinal worms produce a diseased state of the body which they inhabit, various remedies are advised for removing them; many of which are ineffectual, and others very injurious by their violent operation. Drastic purges operate upon tænia, partly by irritating their external surface, making them quit their holds, and partly by the violent contractions of the intestine, which sometimes divide their bodies, and even kill them by bruising. A simple remedy promises to be successful,—small electric shocks frequently sent through the regions of the abdomen; the lives of the lower orders of animals seeming to be easily destroyed by such shocks of electricity as do not injure the larger and more perfect animals.

Animalcula of various uncommon shapes may be produced by mixing different substances with water,

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circulating vessels of the mother, and so have been conveyed to the fœtus.

and other fluids. Common black pepper and water, hay suffered to become putrid in water, the water from a dunghill, or that in which flowers have long remained, will afford animalcules in astonishing numbers. The circumstances attending the production of *animalcula infusoria* are very surprising. In four hours, an infusion of cantharides has produced animalcula less than even the tails of the spermatic animals herein described. Neither do they seem subject to the fate of other animals; but several kinds, by dividing themselves in two, enjoy a sort of immortality. Nor do the common methods by which other animals are destroyed, seem effectual for destroying their vital principle. Hot mutton-gravy, secured in a phial with a cork, and afterwards set among hot ashes to destroy as effectually as possible every living creature that could be supposed to exist in it, has nevertheless been found swarming with animalcules after standing a few days. The Philosophical Transactions, vol. xix. give a curious account, of animalcules produced from an infusion of potatoes and of hemp-seed, by Mr. Ellis.

LECTURE XXXVI.

Spermatic Animals. According to Lewenhoek, animalcules are found in the semen masculinum of every animal. Their general appearance is much the same, nor does their size differ in proportion to the bulk of the animal to which they belong. The bodies of all seem an oblong oval, with long tapering slender tails by which shape they resemble *tadpoles*, and have been frequently so called; though their tails in proportion to their bodies, are much longer, and the animalcules in the semen of fishes have tails much longer and more slender than those in other animals, so much that the extremity is not discerned without the best glasses, and the utmost attention.

The numbers of these animalcula are inconceivable. On viewing, with a microscope, the milt or semen masculinum of a living cod-fish, innumerable multitudes of animalcules were found therein, so diminutive that he supposed at least 10,000 of them in the bulk of a grain of sand; whence he concludes that, the milt of this single fish contained more living animalcules, than there are people living in the world. To find their comparative size, Lewenhoek placed an hair near them; which, through his microscope, appeared an inch in breadth; and he was satisfied, that sixty such animalcules could easily lie within that diameter; hence, their bodies being spherical, two hundred and sixteen thousand are but equal to a globe whose diameter is the breadth of a hair; a calculation almost exceeding belief. These animalcules appear very vigorous, and tenacious of life; for they move long after the animal whence they are taken is dead. They have this peculiarity also, of being continually in motion, without the least rest or intermission, provided there is fluid sufficient for them to swim in. These animalcula are peculiar to the semen; nothing that has the least token of life being discovered, by the best glasses, in either the blood, spittle, urine, bile, or chyle. Great numbers, however, are found in the whitish matter that sticks between the teeth; some of an oval figure, and others resemble eels.

Buffon having procured the seminal vessels of a man who died a violent death, extracted all their liquor while still warm; and, having examined a drop with a double microscope, large filaments appeared, in some places spread out into branches, and in others intermingled with each other; these clearly appeared agitated by an internal undulatory motion, like hollow tubes which contained some moving substance. Two of these filaments, joined longitudinally, gradually separated in the middle, alternately approaching and receding, like two tense cords fixed by the ends, and drawn asunder in the middle. They were composed of globules that touched, and resembled a chaplet of beads. Afterwards the filaments swelled in several places; and, from the swelled parts, small globular bodies issued, which had a vibratory motion like a pendulum; and were attached to the filaments, by small threads, which gradually lengthened as the bodies moved. At last, the small bodies detached themselves from the filaments, drawing after them the small thread like a tail. When a drop of the seminal liquor was diluted, these small bodies moved briskly in all directions; and, had they not been seen separate from the filaments, he would have thought them animals. The seminal matter was at first thick, but gradually became more fluid; and in proportion to its fluidity the filaments disappeared, but the small bodies increased. Each having a long thread or tail attached, from which it evidently endeavoured to get free. Their progressive motion was extremely slow, during which they vibrated with a rolling unsteady motion in a vertical direction.

At the end of three hours, the fluidity increasing, more of these moving bodies appeared. They were less encumbered, their tails shorter; their progressive motion more direct, and their horizontal-motion diminished. In six hours the liquor was become as fluid as possible without being decomposed. Most of the small bodies were now disengaged from their threads; their figure was oval; they moved forward with considerable quickness, and by their irregular motions had now, more than ever, the appearance of animals. Those with tails seemed less vivacious than the others: and of those without tails, some altered both their figure and their size. In twelve hours, the liquor had deposited a kind of ash-coloured gelatinous substance, and the fluid at top was almost as transparent as water. The little bodies being now entirely free from threads, moved with great agility, and some turned round their centres. They also often changed their figures, from oval becoming round, and often breaking into smaller ones. Their activity always increased as their size diminished. In 24 hours, the liquor had deposited more gelatinous matter, which, being diluted in water, exhibited an appearance somewhat resembling lace; and in the clear semen itself only few small bodies were seen moving. Next day these were more diminished; and after this were to be seen one globule, without the least appearance of motion.

From these experiments, Buffon concludes, that spermatic animals are not really endowed with life, but they are proper to compose a living creature; and he calls them *organic particles.* The same kinds of animals he found in the fluids separated from the ovaria of females. He also brings additional proof from Needham's observations on the milt of the *calmar* (a species of cuttle-fish), which contains no animalcules: and therefore concludes, that the small moving bodies seen in the semen, are not really endowed with life. Buffon extends the analogy still further; and concludes, that all the moving bodies which are to be found in infusions, animal or vegetable, are similar. To discover (says he) whether all the parts of animals, and all the seeds of plants, contain moving organic particles, I made infusions of the flesh of different animals, and of the seeds of 20 different species of vegetables; and after some days I had the pleasure of seeing organic moving particles in all of them. In some sooner, in others later: some preserved their motion for months, others soon lost it, some at first produced large moving globules, resembling animals, which changed their figures, split, and became gradually smaller. Others produced only small globules, having extremely rapid motions, and others produced filaments, which grew longer, seemed to vegetate, and then swelled, and poured forth torrents of moving globules.

Neither is Buffon content with denying life to those beings where the signs are most equivocal; he also includes in the same rank of organic particles, almost every animal imperceptible by the naked eye, and even some whose motions are perceptible. "Almost all microscopic animals, (says he,) are of the same nature with the moving bodies in the seminal fluids and infusions of animal and vegetable substances. The ells in paste, vinegar, &c. are similar, and have the same origin. There are, perhaps, as many beings that either live or vegetate, produced by a fortuitous assemblage of organic particles, as by a constant and successive generation. Such as the calmar, are mere machines, which, though simple, are very active; others, as the spermatic animalcules, seem to imitate the movements of animals; others resemble vegetables in their growth and extension; others, as those of blighted wheat, can at pleasure be made alternately either to live or die, and it is difficult to compare them; and others, in great numbers, are at first a kind of animals, then become a species of vegetables, again re-animate, and again return alternately to their vegetable state. The eels in paste have no other origin than the union of the grains most essential to organic particles. The first eels are certainly not produced by other eels: but though not propagated themselves, they engender other living eels. By cutting them we discover smaller eels issuing in numbers out of their bodies. The body of this animal seems only a sheath or sac, containing a multitude of smaller animals, which perhaps are other similar sheaths, in which the organic matter is assimilated into the form of eels."

Though philosophers have not yet discovered how these minute creatures are produced; yet that there really are animals much smaller than what we can discern with the naked eye, seems indisputable. The subject indeed, is still obscure, and will require the utmost attention of philosophers as well as further improvement in the construction of microscopes, fully to investigate it. It clearly appears, that their motions are not purely mechanical, but produced by an internal spontaneous principle; hence they must be placed among living animals, for they possess the strongest marks and the most decided characters of animation; and consequently, the supposition of a chaotic and neutral kingdom, can only have originated from a very transient and superficial view of these animalcules. As we see the motions of the limbs, &c. of the larger animals produced by the mechanical construction of the body, and the action of the soul thereon, and are forced, by occular demonstration from anatomical dissection, to acknowledge this mechanism, adapted to produce these various motions; and as, on having recourse to the microscope, we find pieces, which had appeared to the naked eye as the primary mechanical causes of particular motions, to consist themselves of lesser parts, the causes of motion, extension, &c. in the larger; when the structure can be traced no farther by the eye, or glasses; we have no right to conclude that the parts invisible are not equally the subject of mechanism: for this would be merely like asserting that a thing may exist, because we see and feel it, and not exist, when it is not the object of our senses.

In describing the general structure of INSECTS it is necessary to remark, that most of them appear under three very different forms. When a butterfly, for example, lays her eggs, these, when hatched, produce a caterpillar or *larva*, having a soft long body, provided with several short feet, and a head furnished with jaws, and with several small legs. After the animal has existed for some time in this state, it assumes a very different form, and is changed into an oblong body, without any distinct feet, and living without apparent motion. This is called a *chrysalid* or *nympha*. After a certain time, the shell that formed the peripheral covering of this chrysalid bursts, and gives exit to an animal of an elegant appearance, furnished with several long jointed legs, two *antennæ*, and wings. This is the perfect insect.

The MOLLUSCA are more complicated with respect to their internal structure than the two preceding classes; but as their organs of motion are less perfect, they are placed below the crustacea and insects in the general arrangement.

Those animals which are called WORMS, have a very imperfect structure, but they are also superior to insects, in possessing a sanguiferous system. Their bodies are divided into rings, and they have no distinct head. They have, however, a mouth, which is often furnished with teeth, a sanguiferous system, and some of them have evident respiratory organs or branchiæ.

The ZOOPHYTES are the lowest class of animated nature. They have no vessels, no nerves, scarcely any organ of sensation, and often consist only of a simple tube furnished with *tentacula*. They are either free, or attached to a solid trunk. The former consist of four orders, viz. *echinodermata*, that are enveloped in a calcareous covering, and have the intestines floating within its cavity; sea-nettles, having a fleshy or gelatinous covering, and the intestines adhering to the body; *infusoria* or animalcules, that are extremely small, and float in certain liquors; and *polypi*, having a gelatinous body increasing by shoots. Those zoophytes which are attached to a solid trunk, consist of five orders, viz. ZOOPHYTES properly so called, having a medullary substance traversed by a horny substance, and terminated by *polypi* at the branches; *Escara*, having each polype contained within a horny or calcareous cell, without any central axis; *Ceratophyta*, having a solid axis, covered with a sensible fleshy substance, from the hollows of which polypi occasionally appear; *Lithophyta*, having an axis or stony base, the hollows of which serve as receptacles to *polypi;* and *Sponges*, having a base that is spongy, and friable or fibrous.

Many of the Zoophytes are attached to a stem, that is composed partly of animal matter, but chiefly of a concrete earthy substance, resembling the matter of the testaceous shells. This is the case with all those marine productions called corallines, madrepores, millepores, &c.

The CRUSTACEA are generally arranged as an order of insects

Their articulated members are at least ten in number; they have usually a tail, and their body is in general covered with a crustaceous shell; they have rudiments of an internal ear; they have teeth within the stomach, a complete circulating system, and they respire by means of gills. They lay eggs, but their young do not undergo any remarkable metamorphosis in their progress to maturity.

They are distinguished into two orders, in the first of which the body is covered with a calcareous shell; the eyes are moveable and the mouth is provided with mandibles, each surmounted by a *palpi* or feeler. These are the *Canceres.* In the second order, the body is generally protected by a horny substance; the eyes are immoveable, and the mandibles have no *palpi.* These have been called *Entromostacea.*

Reptiles agree in having four distinct articulated members, a very small brain, no external ear, and no *cochlea* within the labyrinth, no distinction of thorax and abdomen, no epiglottis, no *omentum*, no mesenteric glands. Their heart, in most tribes, has two auricles; their lungs are of course confounded with the other viscera. They have two ovaries and two oviducts, and a common passage for the excrements and the *ova*, as in birds. Their bodies are covered neither with hair nor feathers.

The general differences that take place in the structure of reptiles, admit of their division into three orders. In the first of these the heart has always two auricles; the jaws are horny, but without teeth, and the body is covered with a dorsal shell. In the second order, the heart has also two auricles the jaws have teeth, but there is no dorsal shell. In the third order, the heart has only one auricle, the body is naked, and has in most instances four extremities. These are the *batraciens*, or *batracea* of the same author.

The Serpents differ from the reptiles, in having a long body without articulated members, and commonly covered with scales, a heart constantly with one auricle, and having both jaws moveable.

There are several important features in the circulating system of Reptiles and Serpents. Many of the former, especially the turtle, the crocodile, and the *iguana*, have, like the preceding classes, a double heart, composed of two auricles and two ventricles, of which the former are divided by a complete partition, but the latter communicate by an opening furnished with a muscular valve that allows a passage to the blood from the systemic into the pulmonic ventricle, but forbids its return. The large arterial trunks in these animals all rise from the pulmonic ventricle; we say all, because the aorta is composed of three trunks. By this structure the circulation of the blood is more readily carried on during impeded respiration. In most other reptiles, and in most serpents, the heart is simple, consisting of one auricle and one ventricle. The blood-vessels of these animals are in general much less numerous, in proportion to the size of their bodies, than in the preceding classes.

The intestines of Insects vary considerably in the different tribes and species. In general, those insects which feed on vegetables, have this canal longer and more complicated than those which feed on animal food. There is a remarkable distinction in this respect, even between the larva and the perfect insect. In the voracious larvæ of beetles and butterflies, the intestines are ten times as large as in the perfect insect of the same tribes. The whole alimentary canal of the locust is very complicated, for besides a membranous stomach and a gizzard, these insects have several cæcal processes, and a pretty long intestinal tube.

In the CRUSTACEA there is a single muscular cavity, analogous to a ventricle, from which the blood is propelled into the arteries of the system, and passes through the respiratory organs, before it returns to the ventricle. There is no real circulating system in INSECTS, in WORMS, or in ZOOPHYTES, but in the first of these classes there is a membranous tube, closed at both extremities, and without any ramifying vessels, situated along the back. In this tube alternate contractions and dilatations may be observed to take place.

The brain of reptiles and serpents is small and simple, consisting of five tubercles, as there is no evident medulla oblongata. In these animals the spinal marrow is of prodigious size when compared with the brain. One of the most remarkable circumstances in the brain of fishes, is that it does not fill the cavity of the skull; and that in general it is surrounded by a salt, fatty fluid, contained within a loose cellular membrane. In these animals too, the optic nerves evidently cross each other. Crustacea and insects have properly no brain, but only a nervous cord full of knots or ganglia, called the spinal marrow, though improperly, as these animals have no spine, and their knotty cord neither resembles the spinal marrow of other animals, nor is it always situated along the back. The nervous system of mollusca and worms nearly resembles that of insects.

The lungs of REPTILES and SERPENTS are remarkable for the large size of their air-cells. In most of the animals of these classes, there is one large cavity in the centre of the lung, and the sides of this organ are composed of smaller cells. In turtles, however, the texture of the lungs is uniform, but the cells are very large. The lung of serpents consists of a single lobe of a much longer form.

The lowest classes of animals, zoophytes, and polypes, have no visible marks of a nervous system, though it is more than probable that they are capable of feeling, if not of tasting. All the classes of animals above these, however, have sensitive organs more or less perfect. All of them have nerves, most of them *ganglia*, and a great many possess a brain.

In most Reptiles, and all Serpents, the cuticle is but loosely attached to the subjacent integuments, and is cast off periodically. In the latter of these classes it is entirely scaly. In some of the reptiles, as in the salamanders and frogs, the cuticle may be considered as a mucous membrane, consisting of several large pieces, which fall off every year at different periods.

The Mollusca have a cuticle; and in those which inhabit shells, the surface is in general covered with a thin cuticle, which may be easily detached, either by drying, or by the action of hot-water.

All insects possess a cuticle; and in their larva state this membrane is repeatedly cast off, and exchanged for another, better adapted to the increasing size of the animal.

Most of the Mollusca have numerous and very strong muscles. In those which crawl or swim, there is a very compact tissue of fleshy fibres, below the skin, which adapts them to these motions. In the testacea there are particular muscles for fastening the animals to their shelly covering; and in some of the naked acephala, there is a peculiar fleshy body surrounding the animal, called its cloak.

Most reptiles have three eye-lids, like birds, and in some, the nictitating membrane is extremely moveable. They have also very large lachrymal glands. In serpents there is no proper eye-lid, but the cornea is defended by the transparent production of the cuticle above-mentioned.

The structure of the eyes in insects is extremely curious. They can scarcely be said to possess any humours; but in most the cornea is exceedingly convex, and is divided at its peripheral surface into a number of small six-sided plates or facets, forming altogether a hard, elastic, transparent membrane, which may be considered as a compound lens.

There seems little doubt that in crustacea and insects, the antennæ are very delicate organs of touch; and most naturalists, by giving the name of palpi, or feelers, to the neighbouring prominences, have, whether justly or not we cannot determine, assigned to them the same office.

Many of the mollusca have either horns or tentacula, which appear to serve the purpose either of feeling or of seizing their prey. The same is the case with the tentacula of zoophytes and polypes. Whether worms, properly so called, have any other organs of touch than the delicate skin in which they are enveloped, is uncertain.

The smelling organs of insects are by no means ascertained, though we cannot doubt that they possess the faculty in a high degree. Some have supposed the antennæ to be the olfactory organs; but Cuvier thinks that the structure of these parts wholly disqualifies them for that office. Some have considered the anterior parts of the palpi as the smelling organs, and Blumenbach thinks this a more probable conjecture.

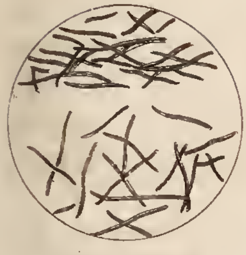
Most of the reptiles have a tympanum, semicircular canals, and a eustachian tube; but in serpents, except in the blind worm, (*anguis fragilis*,) both the tympanum and eustachian tube are wanting. In the crocodile there is some vestige of an external auditory passage, which is completely wanting in every other species of these classes. In lizards and serpents, as well as the crocodile, there are soft stony bodies within the vestibule; and rudiments of similar bodies are also found in frogs.

The scales of fishes afford a great variety of beautiful objects for the microscope. Some are long; others round, square, &c. varying considerably, but not

MICROSCOPIC OBJECTS.

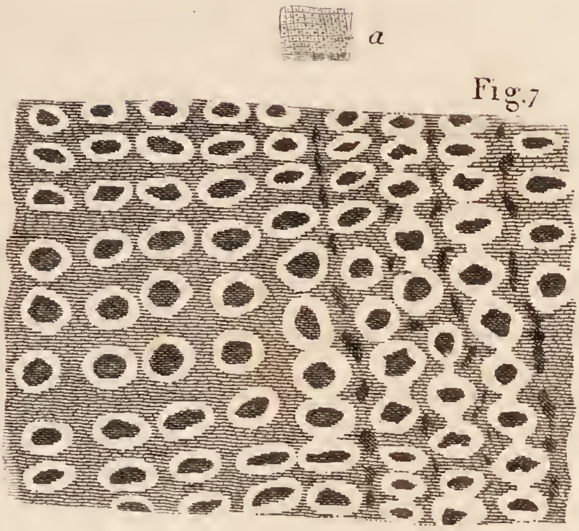
Pl.1.Vol.2

Fig.1



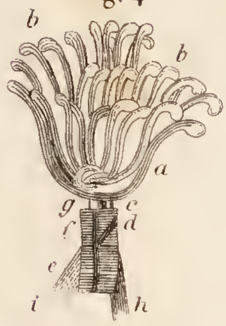
Eels in Paste

Fig.7



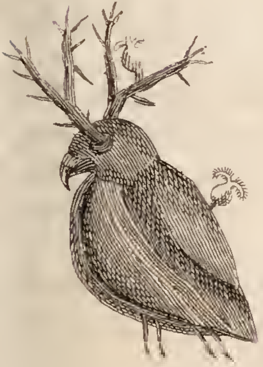
Egg cells of the Moth.

Fig. 4



Bell Flower Polype

Fig. 2



Water Flea

Fig.8

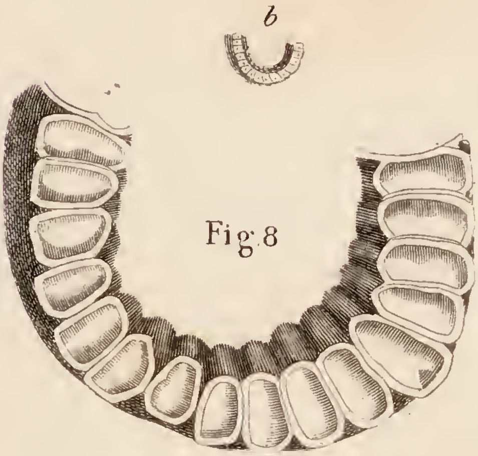
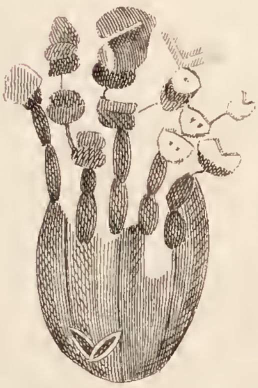
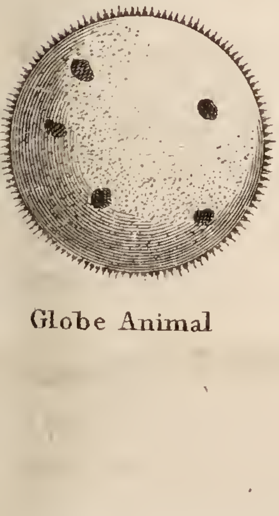


Fig.5



Bell Flower Colony

Fig. 3



Globe Animal

Fig. 9

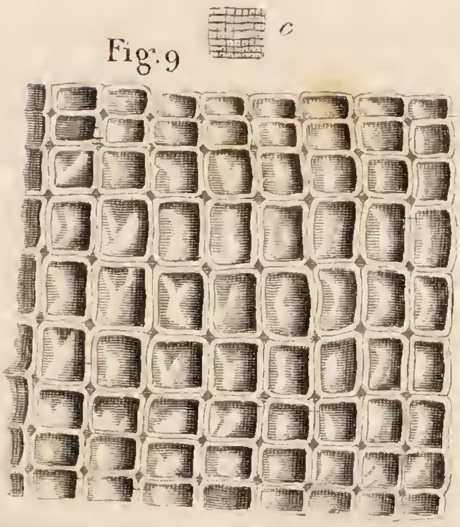
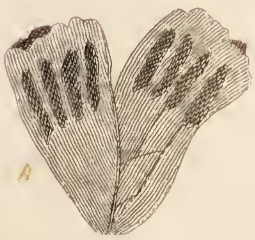


Fig.6



Colonies dividing

only in different fishes, but even in different parts of the same fish. Leeuwenhoeck supposed them to consist of an infinite number of small scales or strata, of which those next to the body of the fish are the largest. When viewed by the microscope, we find some ornamented with a considerable number of concentric flutings, too near each other, and too fine, to be easily enumerated. These flutings are frequently traversed by others diverging from the centre of the scale, and generally proceeding in a straight line to the circumference.

LECTURE XXXVII.

MICROSCOPIC OBJECTS.

WHAT we have already considered makes but a small portion of the wonders which are unfolded to us by the microscope. This instrument has introduced us to a new world of vegetables and animals, and demonstrated, that there are equal order and harmony in the mite's construction, as in that of the whale or the elephant. The only difference is, our weakness of sight prevents our penetrating into the nature and organization of small bodies, which often escape our eyes, and can be perceived only by the assistance of glasses; which teach us, that the smallest objects, wholly unknown to our forefathers, have extension, parts, and a well-organized form. The mention of some examples will lead us to acknowledge the power, wisdom, and goodness of that Deity who affords unto all existence and happiness.

Grains of sand appear of the same form to the naked eye, but seen through a microscope, exhibit different shapes and sizes; globular, square, conical, and mostly irregular; and, what is more surprising, in their cavities have been found, by the microscope, insects of various kinds. In decayed cheese are multitudes of little worms, called mites, which, to the naked eye, appear like shapeless and confused moving particles, but, by the microscope, prove them, as hereafter shown, of a very curious and singular figure. They have eyes, mouth, feet, and a transparent body, furnished with long hair, in the form of prickles.

The mouldy substance on damp bodies, exhibits a region of minute plants; sometimes it appears a forest of trees, whose branches, leaves, flowers, and fruits are clearly distinguished; some of the flowers have long, white, transparent stalks, and the buds before they open are little green balls, which become white. The particles of dust on the wings of the butterfly prove by the microscope to be beautiful and well-arranged little feathers:

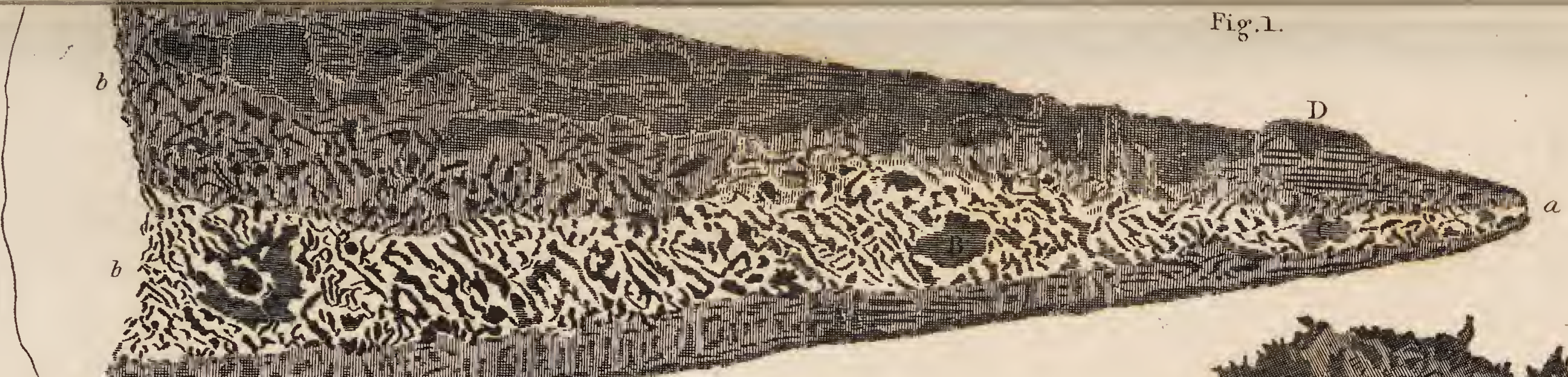
> In down of ev'ry variegated dye
> Shines fluttering soft the gaudy butterfly;
> That powder which thy spoiling hand disdains,
> The form of quills and painted plumes contains
> Not courts do more magnificence express,
> In all their blaze of gems, and pomp of dress.
>
> BROWNE.

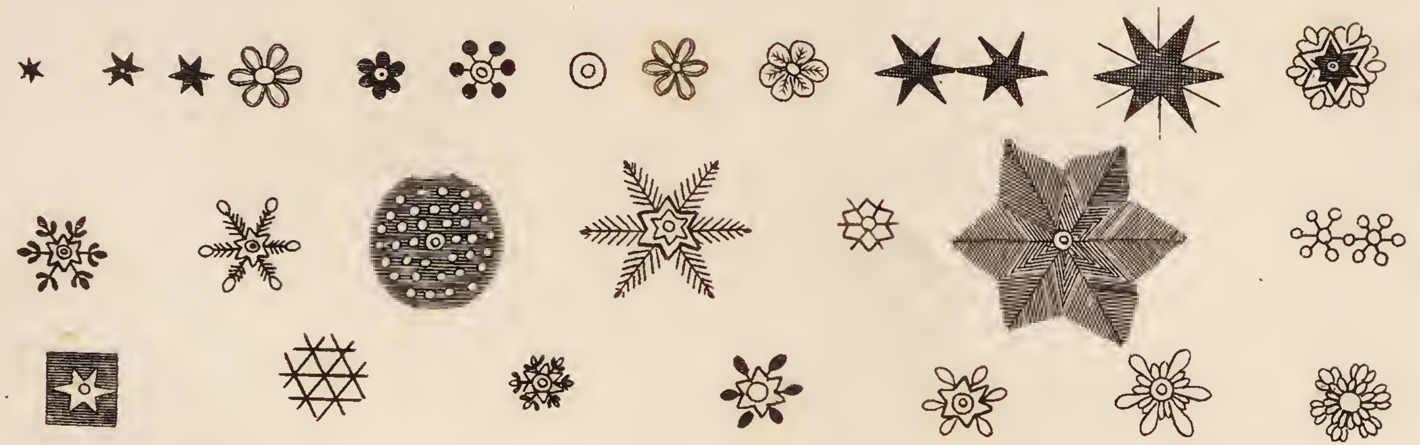
By the same instrument, the surface of our skin has scales resembling those of a fish; but so minute, that a single grain of sand would cover 250, and a single scale covers 500 pores, whence issues the insensible perspiration necessary to health; consequently, a single grain of sand can cover 125,000 pores of the human body.

The microscope displays, in each object, a thousand others which escaped recognition, in each of which others remain unseen, which even the microscope can never bring to view. What wonders should we see, could we continually improve those glasses invented to assist our sight. Imagination may, in some measure, supply the defect of our eyes, and serve, as a mental microscope, to represent in each atom thousands of new and invisible worlds.

How many objects in nature are concealed from our view? What we know is very small compared with the whole works of the Almighty; but limited and imperfect as our knowledge is, we are sure that the Creator has displayed equal wisdom in forming the least objects, as in the greatest. With the same kind and parental care he provides for the wants of the insect that crawls in the dust, as for the whale, which

Fig. 1.





Flakes of Snow magnified.

A full point magnified

London, Published by Sir R. Phillips & C.º Feb. 10. 1823.

appears as a huge mountain in the vast ocean. In this my readers may, the young in particular, imitate the example of Deity, by shewing kindness and humanity to every living creature, for, as they are worthy of His care, they ought not to be ill-treated by us:

> Nor power alone confess'd in grandeur lies,
> The glittering planet, or the painted skies;
> Equal the elephant's or emmet's dress,
> The wisdom of Omnipotence confess;
> Equal the cumbrous whale's enormous mass,
> With the small insect in the crowded grass;
> The mite that gambols in its acid sea,
> In shape a porpoise, though a speck to thee!
> E'en the blue down the purple plum surrounds.
> A living world, thy failing sight confounds!
> To thee a peopled habitation shows,
> Where millions taste the bounty God bestows. BOYCE.

In contemplating the works of God, the effects of His wisdom and goodness are as evidently displayed in the spider's web, as in those laws which connect the sun and his circumrevolving planets. The microscope discovers, in miniature, new worlds, which ought to excite man's wonder, and urge him to religious reverence. Persons deprived of opportunity to examine the curious objects displayed by the microscope, will be glad to know what has been seen by others, and what themselves may herewith contemplate with delight.

The mosses and grass with which the earth is covered, as with a carpet; are composed of many threads and small particles, into which they are divisible. The particles of water are so small, that millions of animalcules may be suspended on the point of a needle; how many then must there be in the rivers and seas! From a lighted candle there issue, in a minute, more particles of light than there are grains of sand in the whole earth; how vast then the number that flow in a day, or a year, or a century, from that immense body, the sun? How indefinitely small must those particles of odoriferous bodies be, which affect large spaces for days and even weeks, without any sensible loss of their weight!

Let us pass to the animated creation. In a summer's evening the air swarms with living creatures. Each drop of stagnant water contains a little world of animated beings. Each leaf of a tree is a colony of insects: every plant, every flower, affords food for millions of creatures; who, but must have seen the innumerable swarms of flies, gnats, and other insects collected in the compass of a few yards! what prodigious shoals must there be over the whole earth, in the immense expanse of the atmosphere! How many millions of smaller insects, and worms, crawl on the ground, or live beneath its surface!

> The artificial convex will reveal
> The forms diminutive that each conceal;
> Some so minute, that, to the one extreme,
> The mite a vast leviathan would seem;
> That yet of organs, functions, sense partake,
> Equal with animals of larger make.
> In curious limbs and clothing they surpass
> By far the comeliest of the bulky mass.
> A world of beauties! that through all their frame,
> Creation's grandest miracles proclaim. BROWNE

Did not experiments, and observations by the microscope, prove the fact, it would be incredible that there are animals a million times smaller than a grain of sand, yet endowed with organs of nutrition, motion, &c.? There are shell-fish so small, that, even through a microscope, they appear scarcely larger than a grain of wheat, and these are living animals inclosed in hard houses. How inconceivably fine are the spider's threads! as thousands would scarcely be as thick as common sewing silk. How small is the mite, and yet, this almost imperceptible atom, seen through a microscope, is a hairy animal, perfect in its limbs, active in its motions, of a regular form, full of life and sensibility, and provided with all requisite organs. Though scarcely visible to us, it is made up of parts, infinitely smaller than the whole. How minute then must be the particles of those fluids which circulate through the veins of such animalcules!

Of the Point of a fine Needle:—Forms of the Flakes of falling Snow:—of Mites found in Cheese:—and of the Full-point used in Printing.

We shall notice some minute objects, as seen through a microscope. The first is a piece of a small needle. (Fig. 1. Plate VII.) The point is so sharp that the naked eye cannot distinguish any of its parts; but through a microscope it appears uneven and irregular, as *a.* The piece represented is about $\frac{1}{20}$th of an inch long; and appeared to the naked eye perfectly smooth and polished; but when magnified, what a number of holes and scratches are apparent! How rough the surface! how devoid of beauty! and what a proof of the deficiency of art; whose most laboured productions, when examined with organs more acute than those by which they were framed, lose all their fancied perfection! Whereas, in examining the works of Deity, the more extended our discoveries, the more obvious are their beauties and excellencies.

A, B, C, are small holes and roughnesses, like those eaten into an iron bar by rust and length of time; D is some body sticking to it by accident; b b b shew the end where the small piece of the needle was broken off, the better to view it.

As sharp as a needle—is a common phrase, to express exquisite sharpness; and indeed a needle has the most acute point art is capable of making, although appearing rude and clumsy by the microscope. This instrument exhibits numberless instances, in the hairs, bristles, and claws of insects, and in the thorns, hooks, and hairs of vegetables, of visible points many thousand times sharper, with a form and polish that proclaim the omnipotence of their Maker:

The microscopic glass, admiring, bring,
And view the humble hornet's sharpen'd sting;
Then on the slenderest needle turn the eye,
And the vast difference in their points descry:
That view'd, more polish'd seems, acuter far,
This rough as from the forge some blunted bar,
God's smallest work all human skill degrades,
Foils the lost man, and sinks his worth in shades. BROWNE.

No two grains of sand are exactly similar; and flakes of snow afford an amazing variety of configuration, beauty, and size. Hooke, catching the falling snow on a black hat, or a piece of black cloth, first observed the curious figures of its flakes, and presents us, with the several beautiful forms given, (see the Plate.) Every flake consists of six principal branches or stems, from a centre, all of equal length, shape, and make, in the same flake, but different in different flakes.

The rays from every stem in the same flake are so exactly alike, that by observing the configuration of any one stem, short of the others, it may be certainly known.

The figure representing the *dot* produced in printing, appears to the naked eye perfectly round and well defined, but through a microscope, it exhibits like the point of a needle, the imperfections of art, when compared with the precision of nature.

Search the least path creative pow'r has trod,
How plain the footsteps of the forming God!
His art could organs, strength, and sense implant
In the small agile fly, and careful ant:
In the mean mite so much minuter still,
Thy fingers pressing point may millions kill.

BROWNE.

Several species of minute creatures, from their extreme smallness, and some resemblance in form, are called *Mites.*

Fig. 1, Plate VIII. represents a *Cheese-Mite, with its Back uppermost.*—The first figure represents a Cheese-mite placed in a crawling posture, with the back upmost. The shape is that of an egg, like larger insects. It has three regions, or parts. The hinder, seems covered with one entire shell, so highly polished, that, like a convex mirror, it reflects the picture of all the objects round. The middle, or chest, seems divided and covered with two shells, moving one within the other, as the mite finds occasion; and it can expand or contract its snout. The whole body is of a pearl colour, and so transparent that different motions of the intestines may be discerned. In different places grow several long white hairs, some longer than the whole animal, but all straight and pliable, except two from the head, which seem to be the horns.

Fig. 2, represents a *Cheese Mite, with its back downwards,*—somewhat larger than the former; fixed on the back part of its tail, to exhibit the insertion of the legs.

At the small end of the body is the head, having a pair of eyes like two dark specks; the mouth resembles that of a mole; and, when open appears red within. At the snout are little bristles; and viewed at a proper time, it is seen munching and chewing the cud, like a *Guinea-pig.*

It has eight well-shaped and proportioned legs, covered with a very transparent shell; each leg has eight joints fringed with small hairs, in structure similar to crabs and lobsters, and at its end each leg is armed with a very sharp claw. Four legs are placed to move the body forwards; the other four, disposed contrariwise, draw it backward when there is occasion.

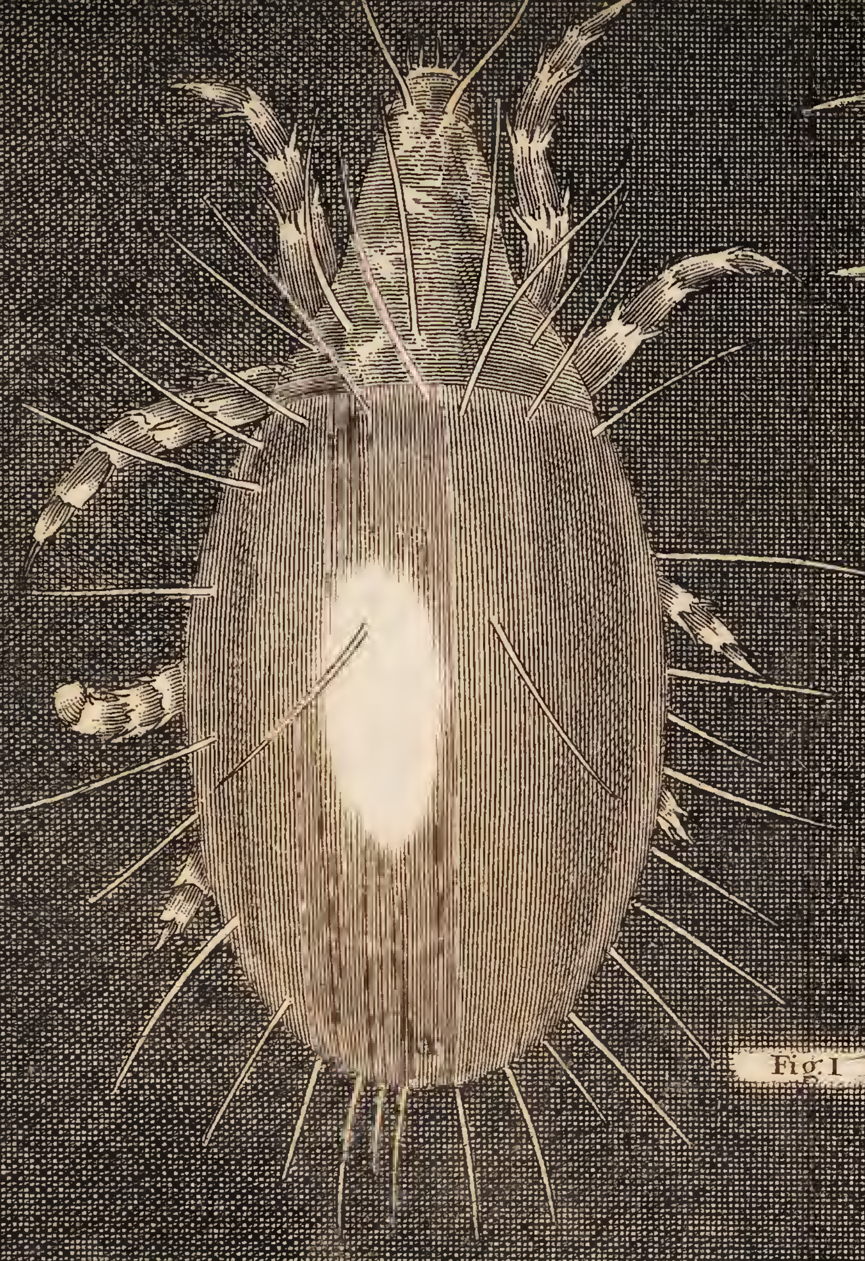


Fig. 1

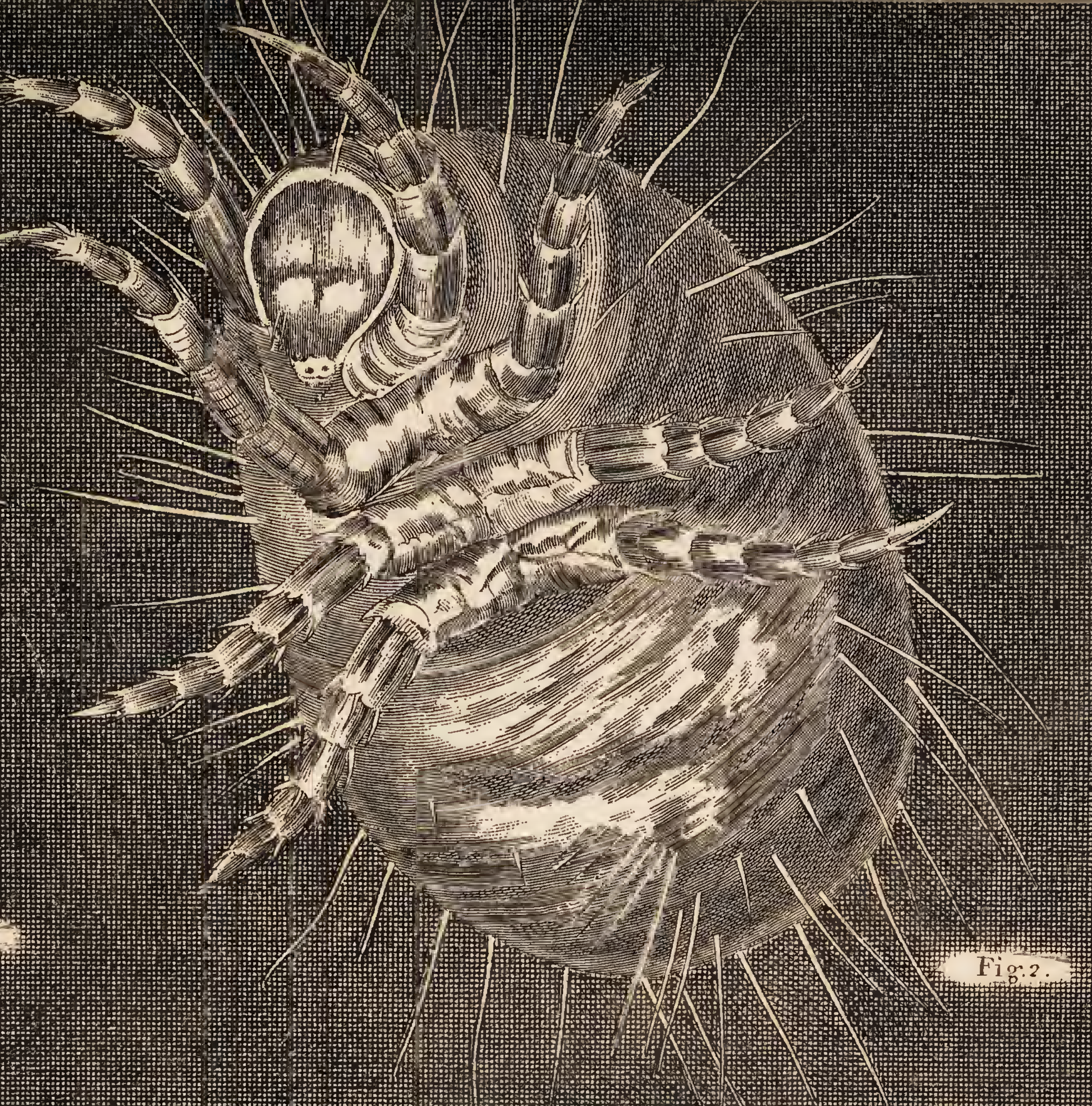


Fig. 2.

To the naked eye, mites appear like dust in motion; the sharpest sight cannot distinguish their parts unassisted by glasses. The females lay eggs, from which very small mites are hatched, of the same shape as the parents; they often shed their skins and increase in size, but never change their form. A mite's egg is a five-hundredth part as large as a well-grown mite, and such mites are not about one-hundredth part of an inch in thickness; so that, a million of full-grown mites or five hundred millions of their eggs, may be contained in a cubic inch.

Insignificant as the mite may appear, it is, with regard to the cheese on which it lives, as large and considerable, as a man upon the earth. The insects upon leaves, are no bad representation of oxen grazing on immense pastures; and the animalcules, in a drop of water, swim about with as much freedom as whales do in the mighty ocean.

The Flea, as seen through a Microscope, Plate IX.—Though the flea is well known as a small brown skipping animal, yet few know its real shape and figure, the structure, strength, and beauty of its limbs and various parts; or the manner of its generation and increase; circumstances discoverable only by the assistance of the microscope.

The Flea's body is oval, composed of shelly scales, curiously jointed, and folding over each other; those on the back meeting on each side those that cover the belly, lying alternately over one and under another. Its neck is finely arched, resembling a lobster's tail, and moving very nimbly, by the jointing and folding of the scales.

The head is small and shelly, a quick, round, and beautiful black eye on each side, K; in the middle is a round black spot, the pupil, encompassed with a greenish glittering circle or iris, as bright and vivid as the eye of a cat.

Behind each eye is a small cavity, at L, with a certain thin moving film, beset with many small transparent hairs; probably the ear.

From the snout, proceed the two fore-legs, between which are two long small feelers, M, M. Each having four joints, and much hair below, and almost between these, is the proboscis, or piercer, N, N, O, consisting of a tube N, N, and a tongue or sucker O, protrusive, or contractile, at pleasure. It has also two chaps or biters, shaped and opening like the blades of a pair of round-topped scissars; with which, it penetrates the skin of living creatures, and leaves a round red spot, commonly termed a flea-bite.

All the shells and scaly coverings are exquisitely polished, and in colour resemble fine tortoise-shell; along the middle scale on the back and belly is a row of strong sharp bristles pointing towards the tail, like the quills of a porcupine, and as large in proportion to the animal. The neck and shoulders are similarly armed, and numbers of bristles are placed about the tail.

But the curious structure and contrivance of its legs more particularly deserve our examination and admiration; as not discoverable in any other creature, and peculiarly adapted to the exigences of the flea: for, living by sucking the blood of animals, which is not obtained without inflicting wounds and causing pain, necessarily productive of resentment and a desire of revenge; it was requisite for the little invader to possess some ready means of escape; else every meal must be paid for with its life. Being without wings, its safety must be entirely owing to its legs; and they are most astonishingly fitted for this purpose; a short one folding within the other, by stretching them to their whole length, with a sudden spring, or jerk, they commonly deliver the little animal from the danger of a pursuit.

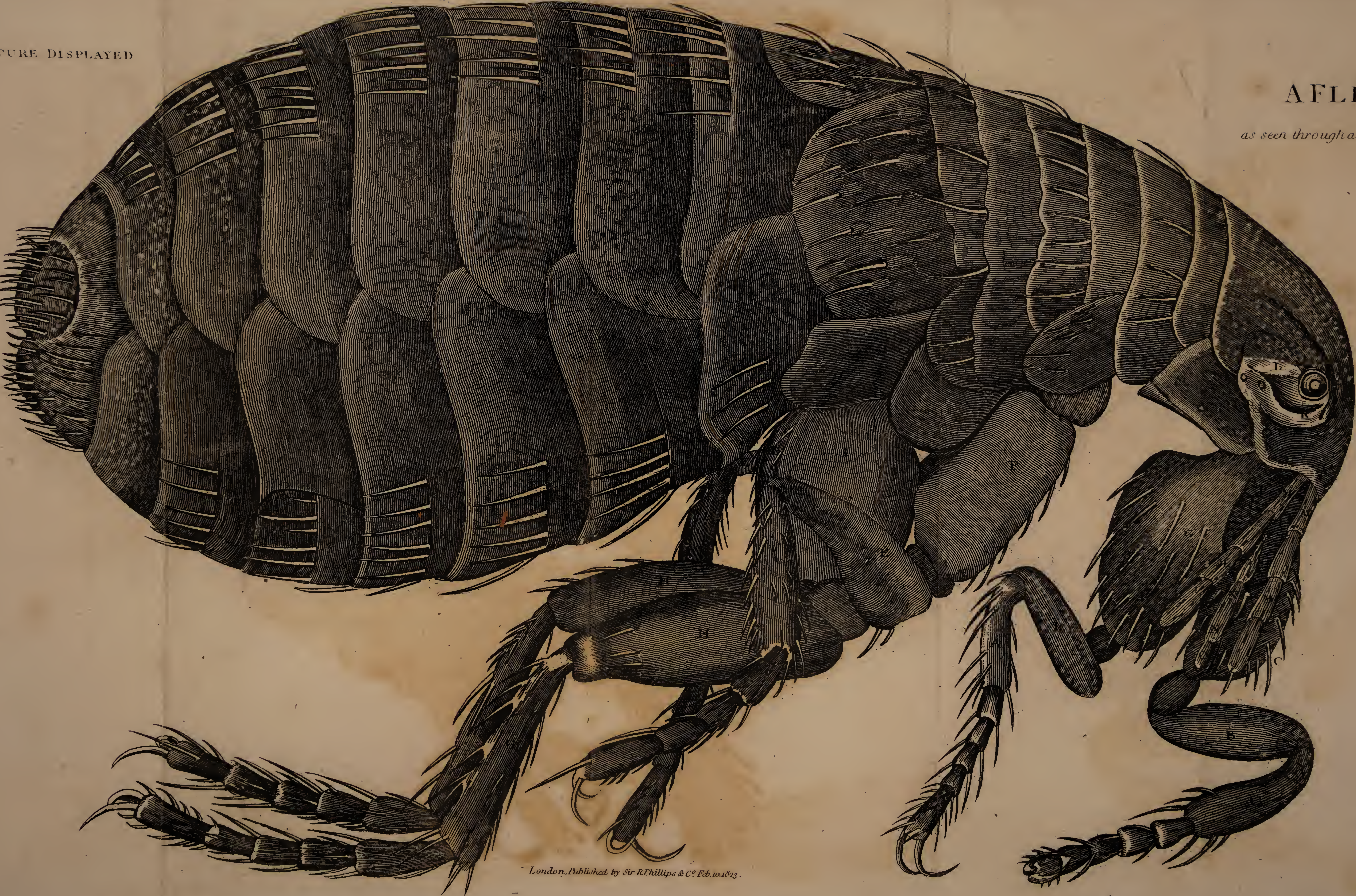
The parts A, A, of the fore-legs, lie within the parts B, B, and those again within the upper and stronger parts C, C, parallel to each other. The parts of the two next legs are disposed contrarywise; the parts D, D, are placed without the parts E, E, which are yet more outward than those parts F, F. In the hinder legs the parts G, H, and I, bend one within another, like the limbs of a double-jointed rule; or like the foot, leg, and thigh of a man. To leap, the flea folds up these six legs, and extends them all at the same instant; and its whole strength being thereby exerted at once, the little body is carried to a considerable distance. The legs like those of a fly, have three principal and larger strong parts, and below them many small joints or divisions, from which proceed long hairs or bristles; and each foot has a pair of long hooked claws, talons, in his leaping, the better to fasten and cling to what he lights upon.

Fleas are produced from eggs, of which a female lays ten or twelve a day, for several days successively; and by a glutinous moisture, attaches to the roots of the hairs of cats, dogs, and other animals, and also to the wool in blankets, rugs, and similar furniture; and they are hatched in the same order, in about four or five days after. From these eggs proceed little whitish worms or maggots, whose bodies have annular divisions, and are thinly covered with long hairs. They adhere closely to the body of the animal on whose juices they feed; or they may be kept in a box, and fed with dead flies, which they greedily devour. They are very brisk and nimble, and crawl like caterpillars, with a lively and brisk motion. After being hatched eleven days, they forbear to eat, lie quiet, as if dying; but, viewed with a microscope, they are weaving a covering or bag round them, with a kind of silk emitted out of their mouths, in which bag they put on the chrysalis or aurelia form, and become milk-white. Under this appearance they continue nine days, darkening in colour and acquiring firmness and strength. On issuing from the bag, they are perfect fleas, able to leap away.

By putting the eggs of fleas in a small glass tube, and keeping it constantly warm in the bosom, in summer they hatch in four days; then, feeding the maggots with dead flies, in eleven days they come

A FLEA

as seen through a Microscope.



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to full perfection, then the maggot spins its bag, and in four days more changes into a chrysalis; after lying thus nine days, it becomes a perfect flea, and in three or four more days capable of laying eggs. Hence in about twenty-eight days, a flea may come from the egg, and itself propagate its kind; their vast increase, therefore is not so surprising, when we consider that from March to November, or December, may be seven or eight generations. After having laid their eggs they soon die like all other creatures that undergo similar changes.

A flea may be dissected easily in a small drop of water, upon a slip of glass, that may then be applied to the microscope. If this be done dexterously, the stomach and bowels, with their peristaltic motion, may be distinguished, with the veins and arteries, minute beyond conception. Two things in this creature merit consideration; its surprising agility, and prodigious strength, by which it can leap above an hundred times its own length. What vigorous muscles! and how weak and sluggish, in proportion to its own bulk, is the horse, the camel, or the elephant! The same may be said of many other insects; a mite, for instance, how much swifter, comparatively speaking, does it run than the race-horse! A philosopher has computed the velocity of a little creature, scarcely visible by its smallness, which he saw run three inches in a second: now, supposing its feet the fiftieth part of a line, it must make five hundred steps in three inches that is it must shift its legs five hundred times in a second.

How sweet to muse upon His skill display'd,
Infinite skill! in all that he has made.
To trace in nature's most minute design,
The signature and stamp of Pow'r divine;
Contrivance exquisite, express'd with ease,
Where unassisted sight no beauty sees;
The shapely limb, and lubricated joint
Within the small dimensions of a point;
Muscle and nerve miraculously spun:
His mighty work—who speaks, and it is done;
The invisible in things scarce seen reveal'd,
To whom an atom is an ample field.

COWPER.

Plate X.—*The Louse as seen through the Microscope.*—The figure of the louse is also magnified so that every part may be known and distinguished; the outer coats are so transparent, that by good glasses the internal structure, disposition and motion and contents of its intestines may be discerned, without difficulty. It is represented with the belly upwards, its claws grasp a hair.

The head A is rather conical, but little flatted. On each side, where whitest, is a large shining black eye, B, B, very protuberant, and mpassed with small hairs, situated a little behind the head.

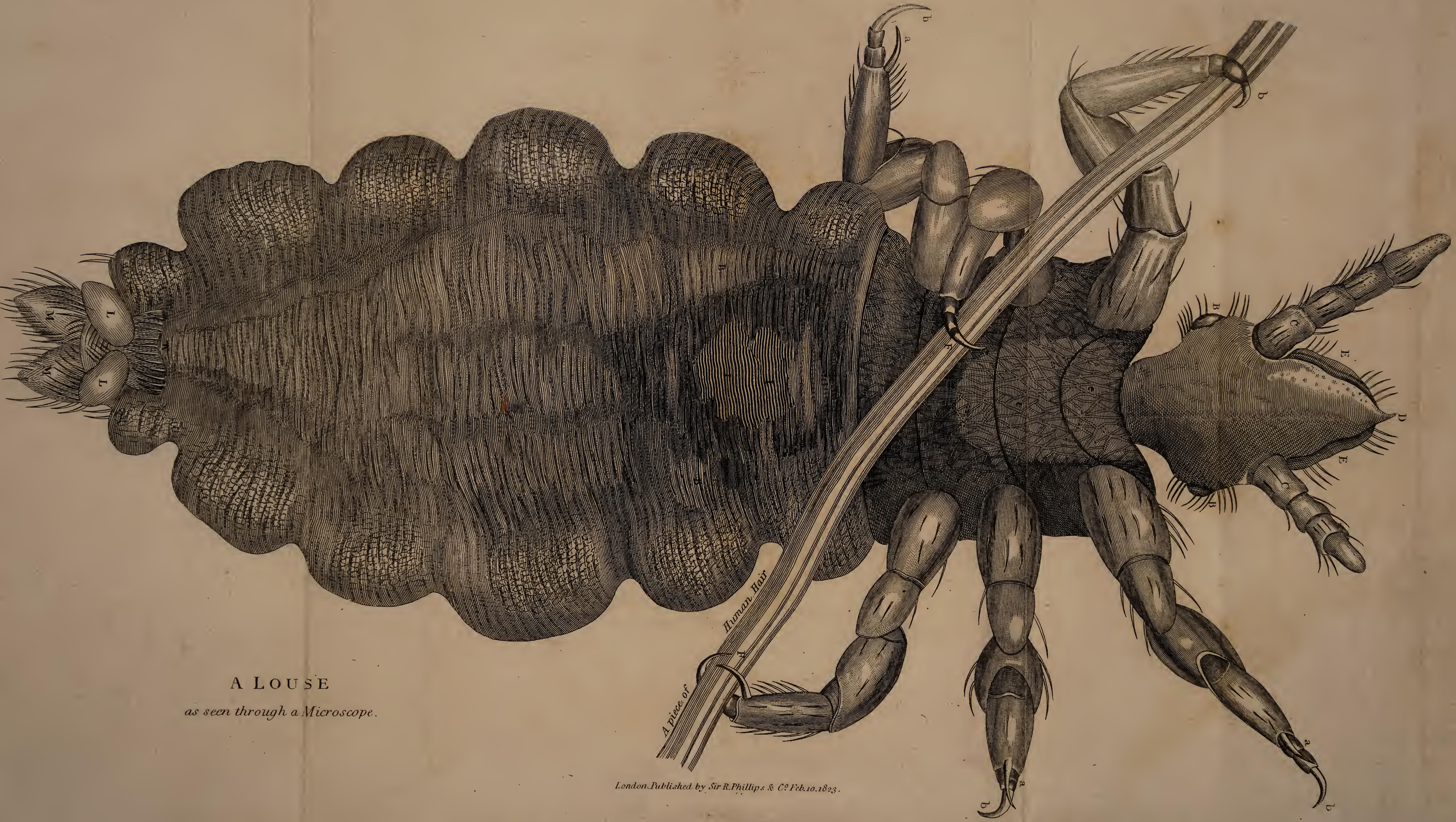
where are the ears of other creatures; and where one might expect to find the eyes, a couple of horns protrude as, C, C, extending so as to defend the eyes from being injured by the surrounding hairs; each horn has four joints, fringed with small bristles.

The head tapers from the horns to the snout D, which ends in a sharp point, and seems a tubular instrument, the louse sucks the blood, on which it feeds and lives.

There seems a resemblance of chaps or jaws, at E,E; yet in another view, those appearances are not discernible. Swammerdam says, it has no mouth that opens; and Hooke observes, that having kept several in a box two or three days, by which they were become exceedingly hungry, upon letting one creep on his hand, he found that it immediately began sucking; and though it neither seemed to thrust its nose very deep into the skin, nor to open any kind of mouth, he could plainly discern a small current of blood pass directly from its snout into its belly; and there appeared, at A, some contrivance like a pump, a pair of bellows, or heart, which by a very swift and alternate dilation and contraction, drew up the blood, and forced it into the body. Though he viewed it very attentively while sucking, he could not perceive that any more of its nose was thrust into the skin than the tip of the snout D; nor did it cause the least pain, although the blood ran through its head quickly and freely; which proves that blood-vessels are dispersed through every part of the skin, even into the cuticula; for, had its whole snout been thrust in from D, to C,C, it would not have amounted to the supposed thickness of that tegumeut; the length of the whole nose not exceeding the three-hundredth part of an inch.

The thorax or breast is covered with a thin, transparent, horny, substance, which did not shrink or become shrivelled like the covering of the belly, by the creature's fasting. Through this Hooke could plainly distinguish that the blood sucked from his hand was variously distributed, and moved to and fro; and within something resembling a bladder, contracting and dilating from the head towards the tail. Across the breast many small milk-white vessels run between the legs, and send out innumerable minute branching, veins and arteries; as in most insects the juices analogous to blood are white.

The louse has six legs, strongly jointed to the thorax; on which, for each pair, a kind of division appears, as *e*, *e*, *e*. They are covered with a transparent shell, and jointed like the legs of a crab or lobster. Each is divided into six parts, with several small hairs issuing, and end with two unequal claws adapted to the particular exigences of the animal, to walk either on the skin or hair. The lesser claw *a* being much shorter than the other claw *b*, when it walks on the skin, the shorter claw does not touch, and then the feet are like those of the mite and many other insects: whereas, when among hairs, the longer claw bends round by its small joints, and meeting with the shorter, both together can take hold and grasp a hair, as with a thumb and finger, after the manner represented in the figure,



A LOUSE

as seen through a Microscope.

London. Published by Sir R. Phillips & Co. Feb. 10. 1823.

where F,F,F, a human hair, is so grasped and held by this creature, that it is in no danger of falling.

The belly is very transparent; but its covering resembles a skin rather than a shell, being grained like the skin of a man's hand, and when the belly is empty, very flacid and wrinkled. The white spot I,I, may be the liver or pancreas, which, by the intestinal peristaltic motion, is moved a little to and fro, with a thronging or justling motion.

After one had fasted two days, all the hinder parts appeared lank and wrinkled; the white substance I, I, scarcely moved; most of the white branches disappeared, as did also the redness or sucked blood in the intestines; the peristaltic motion was scarcely discernible; but upon being suffered to suck, the skin of the belly, and the six scalloped embossments on either side, were quickly filled out; the stomach and intestines seemed quite crammed, and multitudes of white vessels appeared, full and turgid; the peristaltic motion quickened as likewise the justling motion of the substance I, I. The animal was so voracious, that after it could contain no more, it continued sucking as greedily as ever, and emptied itself as quickly behind; proving that its digestion is very rapid. For though the blood when first drawn appeared thin and black, in the intestines it soon became of a ruby colour, and that part carried into the veins was evidently white.

Near the bottom of the belly beset with hairs or bristles appears the anus K, whose aperture is occasionally closed by two parts L,L, below. At the extremity of the tail, two bodies M,M, resemble the rump of fowls, whence issue a number of sharp hairs.

A louse placed on its back, as in the plate, two darkish bloody spots appear; the larger in the middle of the body, and the lesser towards the tail. In the former a white bladder contracts and dilates from the head towards the tail, the pulsation of which is followed by that of the dark bloody spot, in or over which seems to lie the white bladder or the heart, which being priked the louse instantly dies.

They are male and female; Leeuwenhoek, found that the males have stings in their tails, but not the females; and he supposes, that the smarting pain they sometimes give, arises from their stinging, when rendered uneasy by pressure or otherwise; since, when roughly handled, they may be seen thrusting out their stings: but he felt little pain from the piercer, though seven or eight fed on his hand at once. The females lay eggs, or nits, whence young lice proceed, perfect in all their parts, and they undergo no change except an increase in size.

To ascertain from accurate experiment, in what time and numbers these animals increase, Leeuwenhoek put two females into a black stocking, which he wore night and day: in six days, one had laid fifty eggs; and, upon dissection, showed as many more in the ovary; whence he concludes that in twelve days it would have laid an hundred eggs. These eggs, hatching in six days, might produce fifty males and as many females; which latter coming to full growth in eighteen days, might in twelve days more lay also an hundred eggs, which eggs, in another week might produce a younger brood of five thousand; so that in about eight weeks a louse may see five thousand of its own descendants—an increase very doubtful was it not proved by experience.

All vermin adhering to, and feeding on the bodies of different animals, though very dissimilar in form and size, are usually called lice. Of these there are numberless species. And even polypes are infested with vermin or lice that feed on them and torment them. The *earwig* is frequently troubled with minute insects, especially under the setting on of its head; they are white and shining like mites, but smaller: on *Snails* of all kinds, but chiefly the large ones without shells, are many little insects, extremely nimble, that live and feed. Numbers of little red lice, in shape resembling a tortoise, are often seen about the legs of *spiders*. Whilst the spider lives, they cling closely to it; but, if it dies, they leave it. An infinite number of animalcules perpetually float in the air we breathe, sport in the fluids we drink, or adhere to the several objects we see and handle.

Whitish lice are sometimes discovered running nimbly on *humble-bees*, on *ants*, and even on *fishes*; and, perhaps, few creatures are so small that smaller ones do not prey on them.

> Far less than mites, on mites they prey;
> Minutest things may swarms contain;
> When o'er your ivory teeth they stray,
> They throb your little nerves with pain.
>
> SAVAGE.

Of the Fly and its several parts.—The common fly is adorned with beauties, only to be discovered with the aid of a microscope. It is studded from head to tail with silver and black, and its body is covered with bristles pointing towards the tail. The head has two large eyes encompassed with silver hairs, a wide mouth, an hairy trunk or instrument to take in its food, a pair of short horns, and several stiff black bristles. Its trunk has two parts, folding over each other, and sheathed in the mouth. The extremity is harp, like a knife, to separate any thing. The two arts can also be formed into a pair of lips for taking proper quantities of food; and, by the fly's sucking in the air, they serve to pump up the juices of fruits or other liquors.

In some flies, more transparent than others, the motion of the intestines may be distinctly seen working from the stomach downwards; and also the motion of the lungs alternately contracting and dilating. On dissecting a fly, numberless veins appear dispersed over the intestines; and plainly visible by the microscope, though two hundred thousand times slenderer than the hair of a man's beard.

What atom forms of insect life appear!
And who can follow Nature's pencil here?
Their wings with azure, green, and purple gloss'd,
Studded with coloured eyes, with gems emboss'd,
Inlaid with pearl, and mark'd with various stains
Of lively crimson through their dusky veins. BARBAULD.

In most kinds, the female fly has a moveable contractile tube at the end of her tail, by which she can convey her eggs into convenient holes, in flesh, or other substances that afford proper nourishment to the young. From the eggs proceed minute worms or maggots, which, after feeding a while voraciously, and arriving at their full growth, are transformed into little brown *aurelias*, from which soon issue perfect flies.

It would be difficult to enumerate the various flies continually met with in meadows, woods, and gardens; and impossible to describe their various plumes and decorations, surpassing all the magnificence and luxury of dress in the courts of the greatest princes. Every curious observer in possession of a good microscope, will examine them for himself, and, with amazement and humble adoration, carry his thoughts from the creature to the Creator.

It is proper however, to warn our young friends never to put any animal, whatever its kind, to pain merely to gratify curiosity. Dead flies' legs, and wings, and other creatures, will, in the summer season, be readily found in windows, on which they may make their observations.

The *foot of a fly*, Fig. 1, Plate XI. consists of three joints, two talons, and as many pattens or spongy substances, by whose wonderful contrivance, this creature can walk perpendicularly upwards, even against the sides of glass; nay, suspend itself, and walk with its body downwards, on the ceilings of rooms, and the under surfaces of other things, with much facility and firmness.

The two talons are handsomely shaped, as A,B, A,C, and very large in proportion to the rest of the foot. The larger part, A to *dd*, is bristled all over; but thence towards C, and B, the tops and points, which turn downwards and inwards, are smooth and very sharp. Each talon moves on a joint, A, and can be shut or opened at pleasure; so that the points B, and C, having entered the pores of an object, and the fly endeavouring to shut its talons, they not only draw against and so fasten each other, but also pull forwards all the parts of the foot; and the tenters, or sharp points G,G,G,G, run into the pores, where there are any; or on a soft place, make their own way.

Something similar may be discerned by the naked eye in the feet of a chaffer; and if suffered to creep over the hand, or any tender part of the body, its manner of stepping will be as sensible to the feeling as to the sight.

But, as the chaffer, notwithstanding its contrivance to fasten its claws, often falls in attempting to walk on hard and close bodies; so likewise would the fly, had not nature furnished its foot with a couple of pattens or spunges, D,D.

From the under part of the last joint of the foot K, proceed two small, thin plated, horny substances, each consisting of two flat pieces D,D. These, about F,F, *f*, *f*, seem flexible, like the covers of a book, by which the two sides *ee*, *ee*, do not lie always in the same plane, but sometimes shut closer, so that each can take a little hold. But the bottoms of these spunges are also beset with small tenters, like the wire teeth in a wool-card, their points inclining forward; by these the two talons draw the foot forwards, and the spunges being applied to the surface of the body upon which the fly walks, with the points of all their bristles standing forwards, and outwards, as *o*, *o*, *o*, *o*, *o*, if that surface has any irregularity, or gives way, the fly can suspend itself, or walk on it easily and firmly. And its ability to walk on glass, proceeds partly from some little ruggedness thereon, but chiefly from a tarnish, or dirty smoky substance, adhering to the surface; so that though the sharp points on the spunges cannot penetrate the surface of glass, it may easily catch hold of the tarnish contracted. *y*, *y*, *y*, are some very long, stiff, sharp-pointed hairs or bristles.

A whole wing, (*fig.* 2.) consists of a fine, thin, transparent skin or membrane, variously folded, platted, and distended over the whole area; and several bones, ribs, or stems, with great regularity and contrivance, disposed so as to strengthen and support the wing, and determine its proper figure.

Their wings all glorious to behold,
Bedeck'd with azure, jet, and gold,
Wide they display: the spangled dew
Reflects their eyes and various hue.
GAY.

The ribs of the wing are covered with little scales; but the fore-edge is armed with little bristles, all whose points are directed towards the tip; and even the whole edge all round the wing, is covered with a small fringe, of shorter and more slender bristles.

The fine membrane between these bony ribs is thick set with innumerable minute sharp-pointed hairs, ranged in regular rows over its whole surface, intermingled with which, may be perceived many little pits or black spots, the roots of the hairs growing on the other side.

Several other flies have infinite numbers of small fibres covering both sides of this thin membrane, instead of minute hairs; and on most moths and butterflies, they resemble the feathers of birds in arrangement, and variegated curious and lively colours.

Fourteen thousand *hemispheres* or *eyes* are distinguishable in the clusters of the drone fly, each a perfect eye, furnished with a cornea, a transparent humour, and a *uvea* or *retina*. Their figure is spherical, very lively, plump, and exactly polished, when the fly is living; dull, shrunk, and flaccid, when the fly is dead.

One cluster being cut from the head, and opened, discovered a clear liquor immediately under the outward skin, resembling the cornea of a man's eye; and a darkish matter behind, on being removed, appeared transparent; with many cavities inside, and ranged in the order of the little hemispheres on its outer surface.

The most remarkable insect for its fine pearled eyes, is the Libella, or Dragon-fly. Leeuwenhoek reckons 12544 lenses in each eye, or 25088 in both, in an hexangular position; each lens having six others round it. In the centre of each lens is a minute transparent bright spot, supposed to be the pupil through which the rays of light are transmitted upon the retina. This spot has three surrounding circles, and seemed seven times less than the diameter of the lens. He also numbered six thousand two hundred thirty-six hemispheres in a silk-worm's two eyes, in the fly state; three thousand one hundred and eighty-one in each eye of the beetle; and eight thousand in the two eyes of a common fly.

The eyes of other creatures seem as if multiplied by motion; but those of a fly are fixed and immoveable, and can only see what lies directly before them, are very numerous, and placed in a round surface, some high, others low, to inform the fly of every thing in which it may be interested. It has many enemies; but aided by the eyes around its head, it can discover whatever danger threatens from above, behind, or either side, even when in full pursuit of its prey directly before it.

These eyes, or little hemispheres, are ranged in all flies and aërial animals, in neat, regular, and admirable triangular rows, as near as possible, and leaving the least possible pits or furrows between them. In crabs, lobsters, or shrimps, whose eyes are less pearled, the pearls have quadrangular order, the rows intersecting at right anles, their number on equal surfaces being less but to recompence his, their eyes are a little moveable; whereas those of flying insects re fixed.—*See the figure, plate II. page* 98.

The goodness of Providence is particularly distinguishable in the ormation and situation of the eyes of different animals, being most uitable to their different necessities and ways of living. In hairs and abbits, whose safety depends on flight, they are very protuberant, nd placed so much towards the sides of their heads, that their two yes take in nearly a whole sphere.

In cats, the pupil is erect, and the shutting of the eye-lids trans- erse; they can so close the pupil, as to admit only one ray of light; nd by throwing all open, they can admit the faintest rays; which an incomparable provision for animals that have to watch and ay-lay their prey both by night and day. But, besides this, some cturnal creatures have a certain radiation, or darting out of rays light, from their eyes, enabling them to catch their prey in the ark; which many people have witnessed in cats.

Some writers have supposed that moles are blind; but attention nd experiments have proved them to have eyes, excellently fitted r their subterraneous mode of life; indeed little larger than a large in's head, but supposed to have a faculty of withdrawing, if not uite into the head, within the hair, as they have occasion to employ r guard them.

The eyes of snails are at the end of their horns, and are thrust out, drawn quite within the head, as the animal thinks proper.

Those of the camelion turn any way, like a lens or convex glass a globular socket, without any motion of the head; and it is very traordinary, to see one eye moving, while the other remains fixed; e turning forwards, while the other is looking behind; or perhaps e looking up to the sky, while the other turns itself towards the round. The conclusion is, that this animal has two optic nerves.

The blue-bottle, or common flesh-fly, (Fig. 3,) enlarged by the mi- oscope, so as to show distinctly all its particular and minute mem- ers and ornaments. A, A, are its protuberant and pearled eyes, or emispheres, ranged in triangular order, which make a considerable art of the head, though smaller than those of the drone-fly. A aly prominent front between the eyes, adorned and armed with rge tapering sharp black bristles, growing in rows on either side, nd bending towards each other near the top, form an arch of bristles, hat almost covers the front B, C, a projecting part at the anterior nd of this arch, and about the middle of the face, two little oblong odies, D, D, like the apices or pendents in lilies, each having one mall joint to C, and another to the front part B. These in the head f the drone-fly are called horns, from their resemblance to the horns f some kinds of beasts. E, E, are brushy bristles or feathers, like he tufts of a cock-gnat, growing from the upper part and outsides of the horns D, D. F, F, are four strong bristles, placed two and two, and bending towards each other, just above the opening of the mouth. G, H, I, is the fly's proboscis or trunk from the middle of the mouth. It seems hollow, and by several joints is moved, thrust out, or pulled in, at pleasure. At H is a knee, or bend from thence, to the extremity, slit into two lips, H G, H I, on their outer sides cov-

THE BLUE BOTTLE FLY IN A MICROSCOPE.

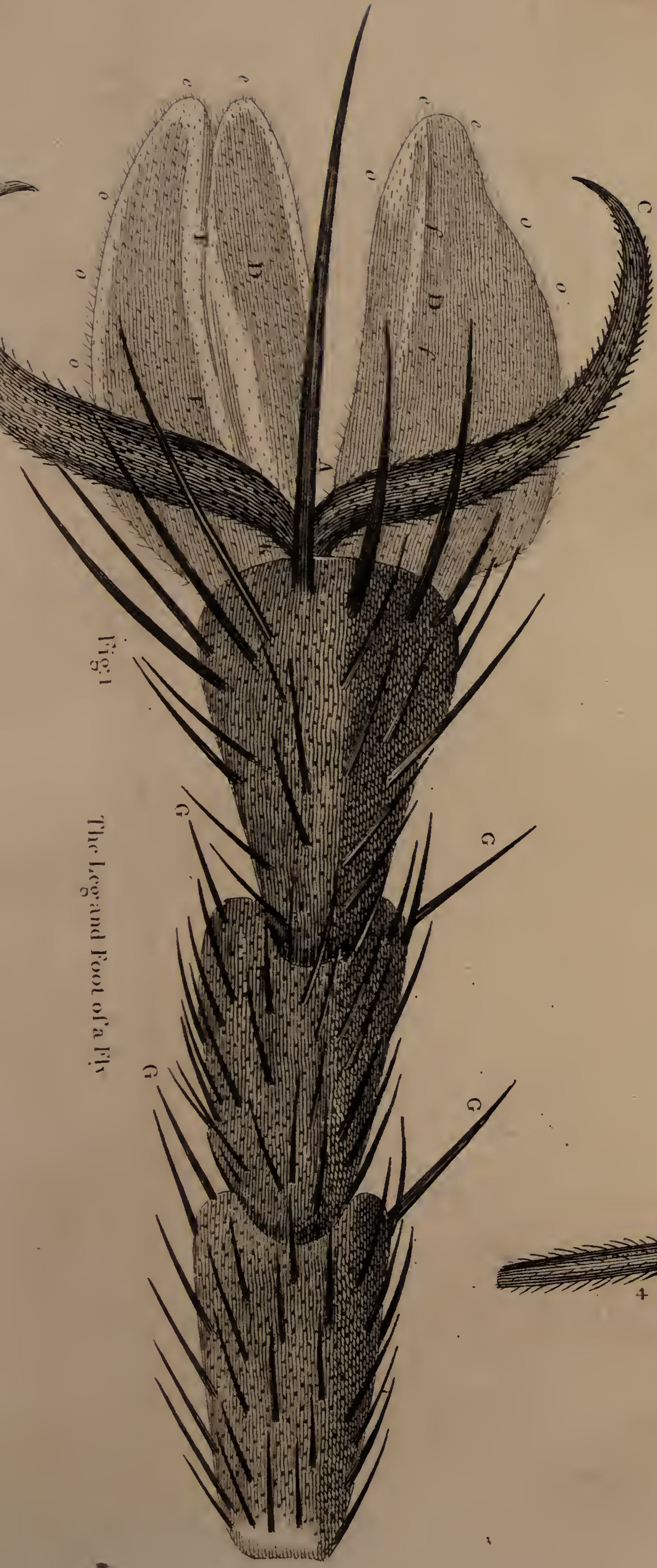


Fig. 1

The Leg and Foot of a Fly

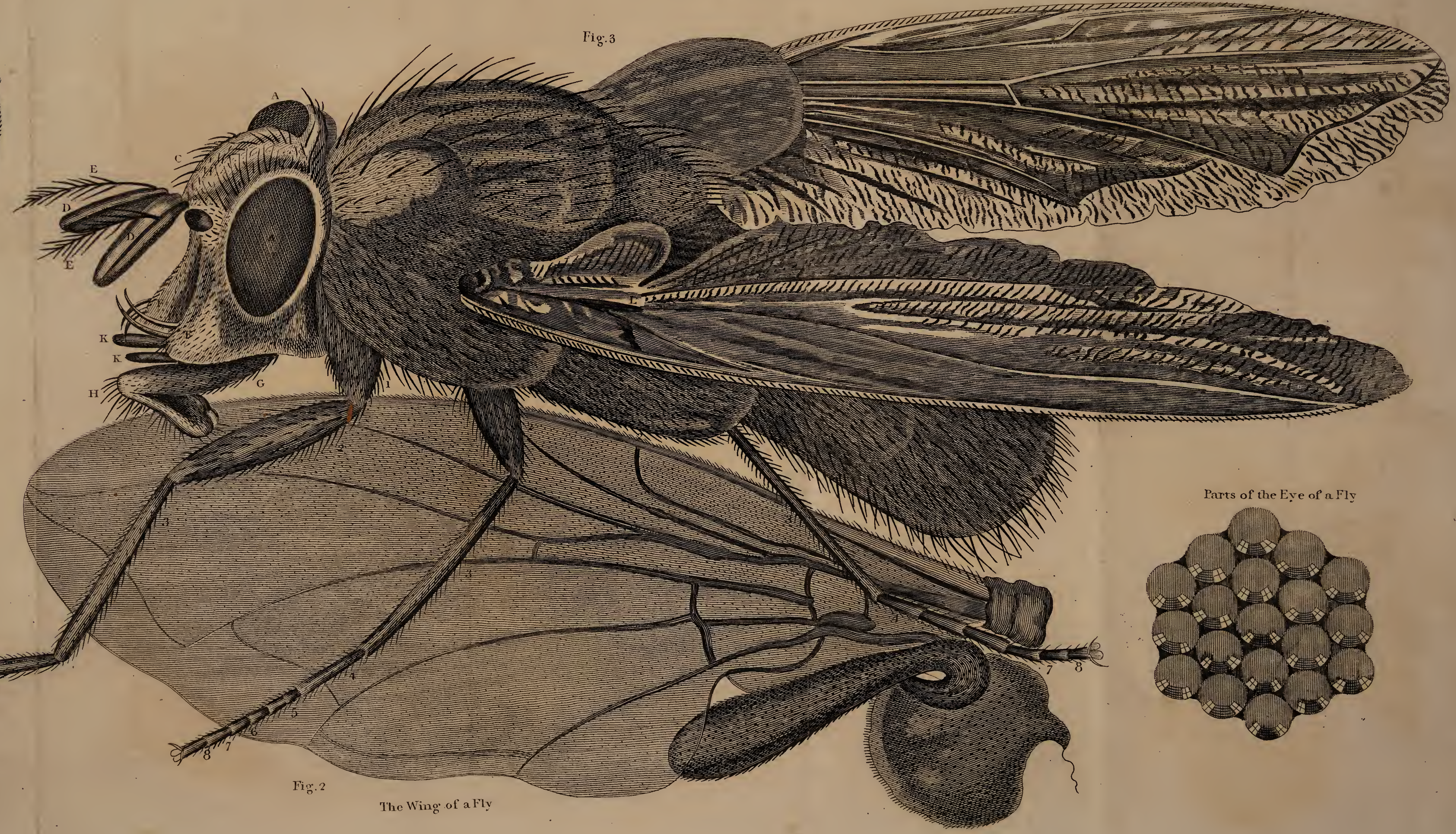


Fig. 3

Fig. 2

The Wing of a Fly

Parts of the Eye of a Fly

London, Published by Sir R. Phillips & Co. Feb. 10. 1823.

vered with large hairs; though those on the upper part of the proboscis are very small. These lips easily open or shut, and hold or take in little pieces of solid food; but when the fly sucks any thing, she spreads them open, and applies their hollow part perfectly close to the surface; thus they serve to pump up the juices of fruits or other liquors. K, K, are two little hairy oblong bodies, in the mouth, growing from each side of the proboscis. These parts are differently shaped, and much larger in the head of the drone-fly, marked G,G. Hooke imagines these may be the organs of smelling.

The middle part or thorax, is crustaceous, strongly made, rounded on the top, and covered with large, long, black bristles, in parallel order, like the quills of a porcupine, all pointing towards the tail. From the hinder and under part grow three large legs on each side, covered with a strong hairy shell, and resembling the legs of a crab or lobster. Each leg is jointed, and of eight parts, 1, 2, 3, 4, 5, 6, 7, 8; on the eighth grow the soles or spunges and claws. Of these six legs, the fly seldom employs more than four to walk with; the two former serve instead of hands, to take up any thing to eat, to clean her mouth, eyes, wings, and body, and for many other purposes. L, L, are the two wings fastened with strong joints to the upper part of the thorax.

The hinder or tail part is of a most beautiful shining blue, exactly like that curious colour of polished steel annealed; and seem a kind of armour, thick set with bristles, similar to those which grow upon its back.

Of Animalcules in Fluids:—how to make Pepper-Water and other Infusions; and of the Animalcules found in them;—of Animalcules in Vinegar and Paste.

By the microscope many kinds of animalcules have been discovered, as different from each other as the horse from the mouse; some indeed so exceedingly minute, that a million would not equal in magnitude a large grain of sand; and, as more and smaller objects have ever been discovered, in proportion to the goodness of the glasses with which they have been viewed, it is highly probable, that there are numberless other species, of a size much less than those already discovered.

Every drop of water, and almost any fluid, except oils and ardent spirits, either does or will, by standing exposed a few days, in warm weather, swarm with living creatures. Some seem natural inhabitants of the fluids in which they are found; others live there only occasionally, in the manner of gnats, which, from eggs dropped in water by their parents, become swimming animals; but, after a short time, shed their skins, appear in a form without resemblance to that before assumed, take wing, and claim kindred with the countless millions which rejoice in the air.

> Mark'd by the magnifying crystal's aid,
> In ev'ry place what proofs will stand display'd!
> Lo! from the stagnant pool one drop obtain,
> Of insects this includes a sumless train;
> Buoy'd in the little pool, they frisk and play,
> Pleas'd with their short existence of a day.
>
> BROWNE.

The *largest* sort are thin and transparent: they turn frequently, have many feet, often seen about the extremities; at one end are some bristles longer than the feet, resembling a tail. Their motion is swift, and their frequent turns and sudden stops would intimate that they were hunting after their prey, probably insects indefinitely smaller than themselves, and have hitherto escaped notice with the best glasses. They employ their feet in both running and swimming; for, putting a hair among them, like rope-dancers, they often creep along it, bending in odd postures.

The second kind are spiral or screw-like; when they lie still, they often thrust forth a fringed or bearded tongue; a small current may be discerned towards them, probably caused by the nimble motion of some fins or legs too minute to be discerned.

Another sort, about the same size, but without tails, resemble a flounder: their feet may be seen clearly as the water evaporates when they move very nimbly.

The next kind appear like slender worms, about fifty times longer than broad; their waving progressive motion is equal and slow. They swim with equal facility any way; and being every where of the same thickness, it is difficult to ascertain the head.

A fifth sort are so small that an hundred in a row would not equal the diameter of a grain of sand; and consequently a million are but equal in bulk to one such particle; their shape is nearly globular.

A sixth kind have also been discerned about the thickness of the last; but twice as long.

The smallest drop of sulphuric acid, only as much as will stick to the point of a pin, put among these animalcules, will cause them all to fall down dead.

A solution of salt or of sugar also kills them; so will ink, and even blood or saliva.

If the water be evaporated, some kinds of animalcules burst; but others, though apparently dead, will revive by supplying them with fresh water.

Hay-water.—New-made hay cut small and put into water, in a few days produces a whitish scum on the surface, which examined by the microscope, contains inexpressible numbers of minute living creatures of various kinds, forms, and sizes. Some are the same as those in pepper-water; but the most is an oval sort of animalcule, in the shape of an ant's egg. They are extremely nimble, and in a continual swift motion backwards and forwards: but sometimes they stop on a sudden, and turn round on their own axis many times with surprising velocity, first one way, and afterwards the contrary.

Another sort common to this infusion are transparent, but curiously ribbed, like a melon; others are transparent at only their extremity; but neither legs nor fins are discernible. Another species of animalcules have bodies nearly spherical, but pointed at one end, like a pear, and resembling filled bladders, in which dark particles seem in continual agitation.

Animalcules like eels, are often met with in many infusions, and other liquors. Their size, and probably kind, varies; some being an hundred times larger than others.

VINEGAR, after standing a few days uncovered, especially in summer, abound with these eels, frequently large enough to be discerned by the naked eye. Cold does them no injury, but, if the vinegar be moderately heated, they will be killed and sink to the bottom.

Dr. Power put some vinegar, full of these eels, into a glass, and poured on it an equal quantity of oil; on then freezing the vinegar, the eels crept into the oil for shelter; but thawing the vinegar, they returned to it. On a few very small grains of sand being put among the eels, they appear embarrassed, and as if struggling to free themselves among large stones.

Fluids, in drops, minutely swell,
These subtile beings each contains;
In the small sanguine globes they dwell,
Roll from the heart, and trace the veins.

Through every tender tube they rove,
In finer spirits strike the brain,
Wind quick thro' ev'ry fibrous grove,
And seek, thro' pores, the heart again. SAVAGE.

So eels in paste are very entertaining objects when examined by any microscope, particularly the solar one, which very plainly distinguishes the motions of their intestines; and, when the water is nearly evaporated, and they near expiring, their mouths appeared opened to a considerable width.

Of Animalcules found in Stagnant Water;—of Gnats, and from what they proceed; their Transformations;—the Wheel Insect.

Leeuwenhoek says, no living creatures appear in rain-water fresh descended, but, after standing a few days, innumerable animalcules of different species, many thousand times smaller than a grain of sand, are visible by the microscope.

In summer, the water in ditches appears sometimes greenish, or reddish; which, examined with the microscope, is owing entirely to the millions of animalcules crowded on the surface. Their bodies are oval and transparent, the middle parts either green or red: seem composed of globules, so similar to the roe of fish, that it is believed to be the same, especially as they are found, after some time, perfectly clear and colourless, when they may be supposed to shed their spawn:

——————— Where the pool
Stands mantled o'er with green, invisible,
Amid the floating verdure millions stray.
——————— Nor is the stream
Of purest crystal, nor the lucid air,
Though one transparent vacancy it seem,
Void of their unseen people. THOMPSON.

The water from dunghills, a deep brown colour, is so thronged with animalcules, that it seems all alive, and must be diluted before they can be sufficiently separated to distinguish their kinds.

An infusion of any herb, grain, fruit, or flower, in common water, will, after a few days, contain some kinds of animalcules peculiar to itself; since every herb, grain, fruit, or flower, is allotted by Providence to be the food of some particular sort of bird, beast, or insect, of the visible or larger kinds, we may imagine it, in like manner, when infused in water, to afford a proper nourishment for some of those numberless species of minute creatures which are invisible to the naked eye, and not to be discovered without a good microscope.

Sometimes in vegetable infusions, and other waters that have stood exposed to the open air, much larger animals than any before described is discerned, of a very singular and surprizing form; this little creature is in its middle state; it was late a worm, and will soon become a gnat;—

> We wonder at a thousand insect forms,
> These hatched, and those resuscitated worms,
> New life ordained, and brighter scenes to share,
> Once prone on earth, now buoyant on the air. COWPER.

In a slimy matter on the surface of water, gnats deposit their eggs and fasten them to something that may prevent their being washed away, or separated too soon. From these eggs proceed minute worms, which, sinking to the bottom of the water, make for themselves cemented cases of fine sand and a sort of glue, open at both ends, for egress or ingress as they find occasion. After a time, they quit these habitations and the figure of worms; they re-ascend to the top of the water, shelled all over, with a large head and mouth, a couple of black eyes, two horns, several tufts of hairs on different parts of the body, and a tail with a brush of hair at the end, which, being smeared over with an oily fluid, serves, like a cork, to keep them above water; their heads being lifted into the air, or plunged into the water, while the tail slides along the surface. When the oil on the tail begins to dry, they shed upon it a new supply from their mouths, which restores the ability of steering where they please, without being wet, or injured by the water. After living thus, their appointed time, a stranger change succeeds; for, resigning their eyes, horns, and tail, and casting their skin, there issues a race of insects belonging to a different element. Their heads adorned with most beautiful and delicate plumage, their limbs of the finest texture; their wings curiously fringed and ornamented; and their whole bodies invested with scales and hair, and themselves actuated with surprising agility; in short, they become gnats, and rise into the atmosphere. And what seems the most wonderful is that a creature, which but a minute before was an inhabitant of the water, would now be drowned were it plunged therein. This little creature is a beautiful microscopic object, its white heart beating distinctly, and the motion of all its intestines being visible.

> The little gnat, in beauties may compare
> With all his rival brothers of the air:
> Transparent feathers, purple, green, and gold,
> His wing, small feet, and gay fringed tail enfold;
> Four sharpen'd spears his head with weapons arm,
> And his pearled eyes with liveliest graces charm.
>
> BROWNE.

In the water or slimy matter, found in leaden pipes or gutters, various kinds of animalcules are often found, and multitudes which have a sort of wheel-work, such as we have described; when the water dries away, they contract their bodies into a globular figure, become of a reddish colour, and fixed in the dry dirt, which hardens as clay; but, when such a piece of dirt is put in water, in about half an hour's time they gradually open, extend their bodies, and swim about; whence it has been concluded, that the pores of their skin are so closed as to prevent all perspiration: thus they are preserved till rain falls, when their bodies open; they are re-animated, and swim about, and take in nourishment:

> Gradual—what numerous kinds descend,
> Evading e'en the microscopic eye!
> Full nature swarms with life: one wondrous mass
> Of animals, or atoms organized,
> Waiting the vital breath, when parent Heav'n
> Shall bid his spirit blow. The hoary fen,
> In putrid streams, emits the living cloud
> Of pestilence. THOMPSON.

Other *Animalcules*, but very little known, though not uncommon, are mentioned by Dr. Leach in the *Linnean Transactions;* of which the most remarkable are subjoined.

The *Linnilus* inhabits the sea, in a crustaceous shell; but its particular place is unknown. The *Assus*, in a crustaceous membranaceous shell, in stagnant ponds, and waters, near Christ Church, Hampshire. The *Argulus*, in a shell, oval, and semi-transparent, adheres to fishes in ponds and rivulets, and to the larvæ of frogs. Its larva has the two anterior legs incrassated, elongated, and terminated by a strong bent claw. The full grown animal lays from one hundred to four hundred ovate and smooth eggs, generally on stones in two longitudinal series, which are hatched in about thirty days. The *Cecrops* has a shell like the Linnilus, of two parts. The female has two ovate coriaceous bags for her eggs, beneath the abdomen, and projecting behind. Its history is unknown; but it is inferred that it inhabits the ocean and attaches to larger marine animals. The *Caligulus* has a similar kind of shell, and inhabits the cod-fish. The *Pendorus*,—shell similar, attaches to the squalus or skate. The *Anthosoma* likewise has a similar shell; and was discovered sticking to a shark, thrown on the Dover coast; adhering solely by its anterior legs, to the axillæ and gill-covers, which were much thickened by the inflammation caused by the irritation. The *Lynceus* has a globose shell; inhabits marshes, is very common in the spring, moving about with great agility among aquatic plants. The female carries her eggs on the posterior and superior parts of her belly. The *Chydorus* has a similar shell, but inflected tail. The *Daphnia* has been mentioned on account of its extraordinary appearance by the microscope. The shell, though apparently bivalve, is but one piece, open in front, the head terminated by a pointed fixed beak; the mouth within the shell; the eye strictly single; and number of legs unknown.

The Species Monoculus,—has its body short, roundish, and covered with a firm crustaceous skin; the four legs ramose, and serve for leaping and swimming; it has but one eye, large, and composed of three smaller. The quadricornis, or four-horned, monoculus, is a very small species, about half a line in length, and of an ashen grey colour. From the head arise four antennæ, two forwards and two backwards, furnished with a few hairs resembling a branch. Between the antennæ, on the fore-part of the head, is a single eye. The body, from the head to the tail, decreases like a pear; being composed of seven or eight rings, continually more straitened. The tail is long, divided, each division having outwardly three or four bristly hairs; on the sides it carries its eggs as two yellowish parcels, filled with small grains, which together nearly equal the insect in size. This minute insect is found in standing pools. Of a number kept in a bottle of water, some will be seen loaded with their eggs, and after a while depositing the parcels, either together or separately.

The name *monoculus* has been given as consisting of individuals which have but one eye; and, from their manner of proceeding forward in the water, they are also called *water-fleas*. The branching antennæ serve instead of oars, the legs being seldom used for swimming. The tail, forked in some species, in others simple, serves for a rudder. Their colour varies from white to green, and red, in a ratio to the fragments of the vegetables on which they feed. The red tint they sometimes give to water, has made some think that the water had turned to blood. Too weak to be carnivorous, they on the contrary fall a prey to other aquatic insects, even to polypi. Their body, compact and hard, is so transparent, that, in some, the eggs in the abdomen are discernible. The water-parrot, and the shell monoculus, are remarkable. The latter has a bivalvular shell, within which he shuts himself when drawn out of the water. The shell opens underneath, the insect puts forth its antennæ, by which it swims very expeditiously in various directions, seeking a solid body to adhere to, and then it uses its feet in walking, by stretching them out through the aperture of its shell.

A pair of these insects was preserved in a small glass tumbler, the one male, the other female, having a bag filled with eggs affixed on each side the abdomen: in fourteen days the increase was astonishing; it would have been impossible to take a single drop of water out of the glass without taking either the larva or a young monoculus. The experiment was repeated by selecting another pair; which at the expiration of fourteen days was increased beyond calculation. The contents of the glass appeared a quick moving, animated mass; and, biversified by colours of red, green, white, ash-colour, &c. afforded, with the assistance of the magnifier, considerable entertainment.

The *Cypris* inhabits pools and ditches of pure water, swims very rapidly, and while in motion conceals the whole body in a bivalve shell. Their members are unknown, having such quick motion while living, and being extremely soft when dead. The *Cythere* has one eye, inhabits the sea, and may be found among the conservæ and corallines left by the tide. The *Cyclops* inhabits fresh waters. The male antennæ have the sexual organ, which in the female is beneath the belly, at the base of the tail, which is abruptly narrower than the abdomen. The *Calanus* has one eye, on the thorax; is found in the German Ocean. The *Polyphemus* has a round head, distinct from the thorax, and seems composed of one large eye. The body is luteous, with few blue spots; it inhabits marshes, and moves quickly by the combined efforts of its short legs and bifid ears, generally swimming on its back.

The *Branchiopoda* has a filiform and very soft body; transparent, of a light brown colour, slightly tinged with green or blue on the head and legs; the front has two moveable processes, notched: those of the female have papilla at the point; at the base of those of the female, are two hair-like filaments; the sexual organs are at the base of the tail. Of this Dr. Shaw says "It is generally found in soft water, especially those shallows of rain water frequent in spring and autumn. At first it seems to resemble the larvæ of a dytiscus, but closer view proves it a more curious and elegant animal. The legs on each side are flat and filmy, and seems so many waving fins, of the most delicate structure imaginable. The Cypris often assaults them, and with such force adheres to their tails and legs as sometimes to tear off a part in the struggle.

The animal seems to delight in sun-shine, as it then appears near the surface of the water, swimming on its back, and moving in various directions, by the undulations of its fin-like legs, using its tail as a rudder. On the least disturbance it starts like a small fish, and, to secrete itself, dives into the soft mud. It changes its skin at certain periods. The females deposit their eggs in March and April, wholly loose in the water, and without any settled order, which appear like very minute brown globes, and when magnified resemble mallow farina; each is thickly surrounded with spines, and coated with a transparent gelatinous substance to their extremities; perhaps designed for adherence to any substance whereon they may fall, or as security against the attacks of other animals.

In about three weeks, the eggs are hatched, and the animal is scarcely larger than the common mite, yet, though so small and young, they swim with great liveliness by three pairs of very long arms or rowers, very disproportionate to the size of the animal, at this period little resembling its subsequent form; but in a few hours the body is lengthened, and the tail-fin begins its formation; the eyes do not now appear pedunculated. On the seventh day after hatching, they approach nearly the form of the perfect animal, yet retain the two first pairs of arms or rowers; the legs now become very visible; about the ninth day the long oars are lost, and it appears more like the animal in its advanced state. But considerable time elapses before the animal assumes its full size.

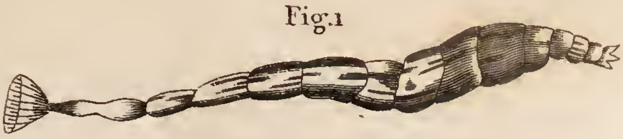
LECTURE XXXVII.

Of the Blood; of what composed; how to be examined;—the Circulation of the Blood;—in what objects best seen.

The microscope has been employed to view the blood, with regard to both its natural course, and contexture; and the knowledge thence derived, has been successfully applied in the science and practice of medicine. By viewing the blood within the vessels,

MICROSCOPIC OBJECTS.

Fig. 1



Larva of the Musca Chamæleon

Fig. 2

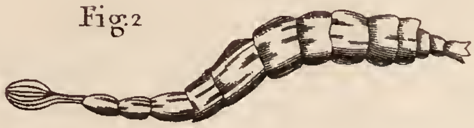


Fig. 6

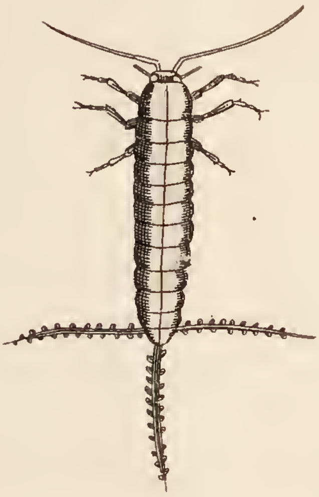
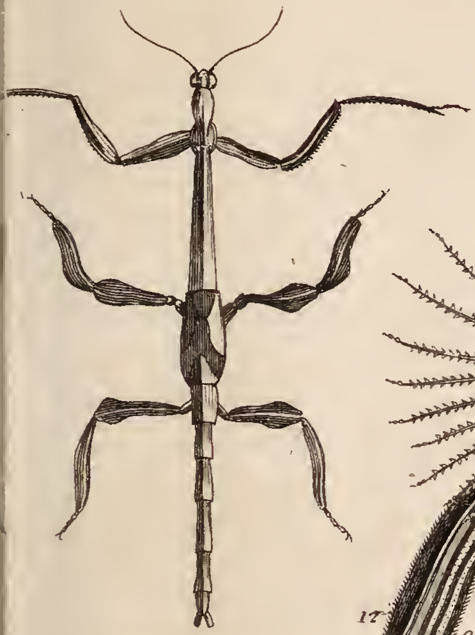
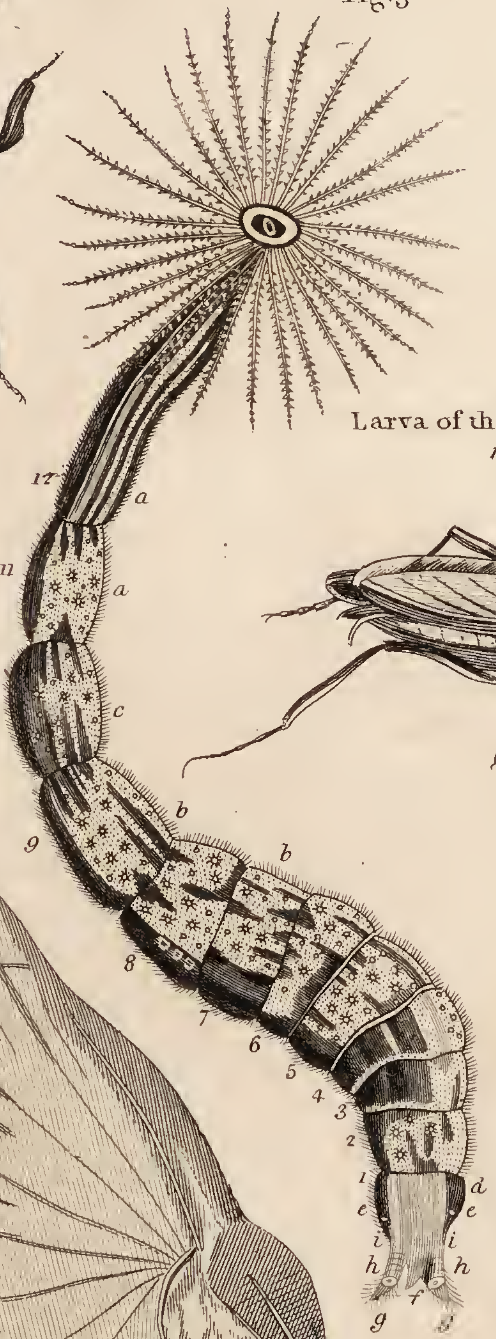


Fig. 5

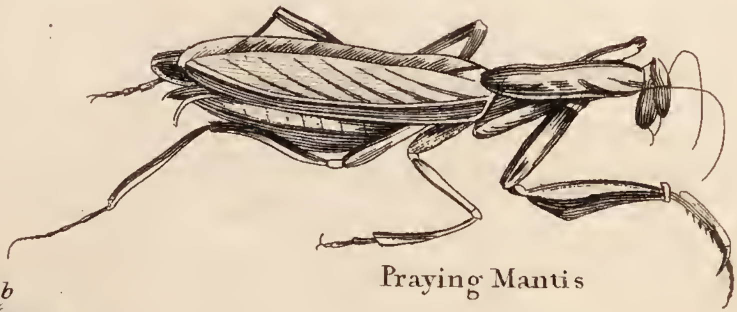


Stick Phasm

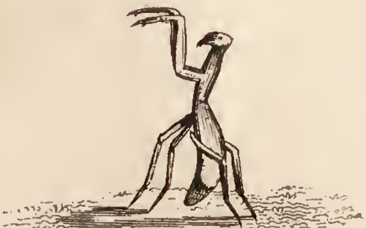
Fig. 3



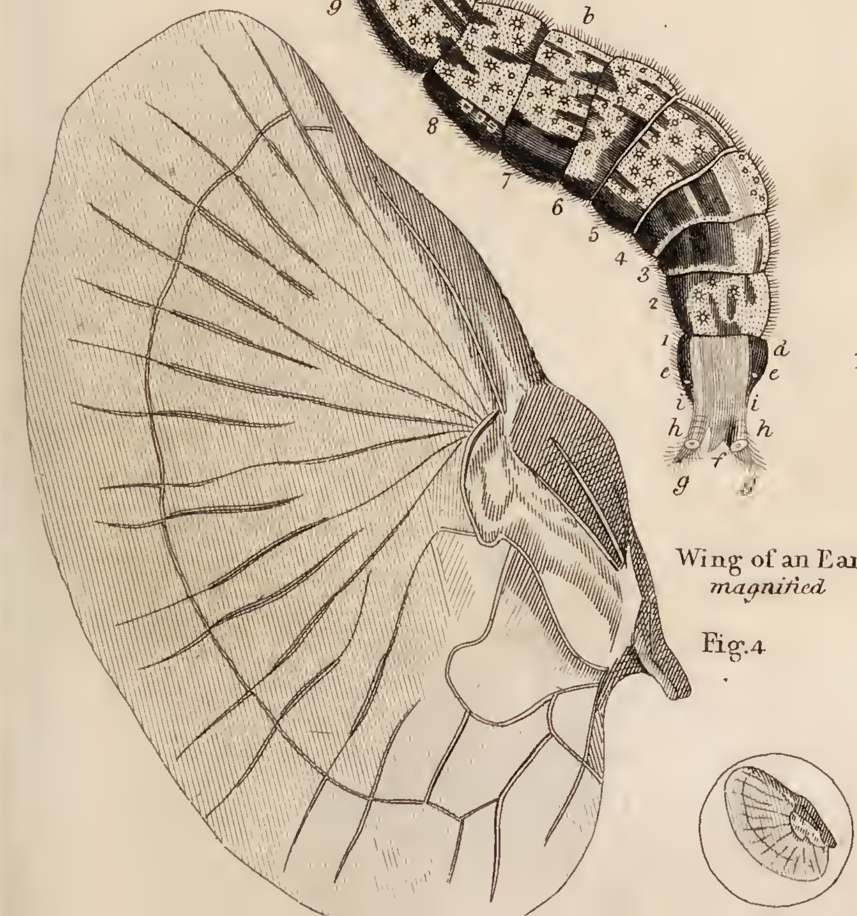
Larva of the Musca Chamæleon *magnified*



Praying Mantis



Praying Mantis



Wing of an Earwig *magnified*

Fig. 4

we judge of the situation, dimensions, arrangements, and ramifications, of the arteries and veins through which it passes, with the general state of the fluid. When taken from the vessels we can examine it minutely, and observe what alterations may occur in the mixture, size, form, and quality, of its particles.

Human blood, and that of all land animals, is a transparent water and serum, in which float round red globules, each made up of six smaller, and more transparent; and each of these, again, composed of six still more minute and colourless; so that every common red globule is a compound of at least thirty-six smaller ones; though probably the division goes on much farther.

To view the blood advantageously,—place on a slider, with a soft hair pencil, a small drop of warm blood, immediately from the vein, spread it as thin as possible on the clearest single isinglass, and apply the first or second magnifier; the globules will then be distinctly seen: or take up a little in a very small capillary tube of the thinnest glass, and place before the magnifier. If a drop be diluted with warm water, and applied either way, some of the larger globules will appear more asunder, and many will be seen divided into their smaller ones. If it be mixed with a little warm milk, several red, unbroken, distinct globules will be seen; but those again separated into their smaller ones will be confounded with the milk itself.

To see the circulation of the blood,—use such small creatures whose transparency permits the looking within them, to see what passes there. In man, and other large animals, the skin's opakeness prevents even the fine blood-vessels being discerned, and much less the current therein.

With regard to the circulation of the fluids, the motion of the intestines, the brain, &c. more knowledge may be obtained by inspecting, with the microscope, insects and small animals, than by the most skilful and curious dissections, or anatomical experiments, on larger subjects. For, the skins of some little creatures are so transparent, that the order and disposition of the vessels underneath are obvious. In several, not only is the general course of the blood readily distinguished, but the figure of the component globules, and their alterations when passing out of the larger into the more minute vessels. Many vessels are so small that even single globules cannot possibly pass through without being compressed into oval shapes; and yet these vessels are large compared with the finest vessels of all, to pass through which the globules must be divided and subdivided into their smallest and most minute component parts.

The wisdom and goodness of Providence are manifest in preventing, by the disposition of the vessels through which they run, the blood from coagulating into masses. The arteries, which convey the blood from the heart to the extremities, are continually diminished, and divided into smaller branches. At every such division, many globules of blood rush with considerable force against an angle directly in their way; which motion seems well adapted to prevent the mass from coagulating. By the veins the blood returns from the extremities to the heart; their diameters enlarge as the tide rolls along; and the smaller branches continually unite and make large vessels, till all their streams fall into one; here, at every conjunction of two branches, the currents rush violently against each other; hence unnatural cohesions are broken or prevented.

When the vessels are extremely small, it is not always possible to distinguish the veins from the arteries. But the larger arteries are observable by a protrusion of the blood at each contraction of the heart, then a stop, and then a new protrusion, which may be plainly seen succeeding one another; whereas the current passes through the veins with an equal and unremitting stream.

The transparent membrane between a frog's hind-foot toes, is commonly employed to exhibit the current and circulation of the blood; and, when well expanded, it may be distinctly seen in both veins and arteries.

The tails or fins of small fishes also may be likewise advantageously used; they present a great number of veins and arteries, with the blood passing different ways through them. Into a glass tube filled with water, put a small eel, well cleaned from its slime; and, stopping both ends, apply the tail part to the microscope, and the circulation will be readily discovered. It will be as well seen in the tail of a small flounder, and in other fish whose skins are transparent.

Leeuwenhoek says, he saw, in the utmost extremity of a very small fish's tail, how the larger arteries were divided into others more fine and evanescent; and that many of the smallest veins, returning from the extremities, met at last in some larger vein. In some vessels there appeared a surprising agitation of the blood; and in the larger arteries seemed a continual new protrusion, or acceleration of the blood's course from the heart; but in the smaller arteries the motion seemed equable; and, though in the minutest vessels there appeared no colour, yet in the larger vein or artery, though near the tail, the blood was plainly red. A small part of the tail had thirty-four veins, and as many arteries. The whole fish was half an inch long; of course the tail must be proportionally small; yet in a part of that, the circulation was visible in thirty-four places, and its current in sixty-eight vessels! and these vessels were far from being the most minute. How inconceivable, then, must be the number of circulations in the human body; of course we need not be surprized to behold it issuing forth at every prick of a needle.

Of the Scales of the Human Skin; how examined;—of the Pores of the human Body; how examined;—of Animalcules found between the Teeth;— of the Itch;—of the Stings of Insects.

The Scales on the Human Skin.—The scarf-skin, or outward covering of the body, is remarkable for its *scales* and *pores.* The former are so minute, that two hundred of them may be covered with a grain of sand; of course, they could never be discerned by the naked eye. They are placed, as on fishes, three deep; that is, each scale is so covered by two others, that only a third part of it appears; which, lying one over another, may be the cause why the skin of the body appears white; for about the mouth and lips, where they only just meet, and do not fold over, the blood-vessels are seen through, and the parts look red. The perspirable matter issues between these scales, which lie over

A piece of skin from between the fingers, the forehead, neck, arms, or any other soft part not hairy, best shews the scales; for where the skin is callous, they are as if glued together. When scraped off with a penknife, put into a drop of clear water, and so applied to the microscope, they are seen to advantage.

To view the pores, slice off the upper skin with a sharp razor as thin as possible; then cut a second slice from the same place, which apply to the microscope; and, in a piece not larger than a grain of sand would cover, innumerable *pores* will be perceived, as plain as little holes pricked in paper by a fine needle may be discerned when held up against the sun.

Leeuwenhoek endeavours to give some notion of the incredible number of pores in the human body. He supposes, on a very moderate calculation, that one hundred pores are in the length of one-tenth of an inch; consequently in an inch there will be twelve thousand; of course, in a surface equal to twelve inches square, there will be one hundred and forty-four millions; and if the superficies of a middle-sized person be reckoned at fourteen feet square, his skin will have two thousand and sixteen millions of pores, through which, in health, the perspirable matter is ever issuing.

The pores through which we perspire, are more particularly remarkable in the hands and feet; for, when the hand is well washed, and examined with a good glass, there appear in the palm, or upon the ends and first joints of the thumb and fingers, innumerable little ridges parallel to each other, of equal bigness and distance; upon these ridges may be perceived by the naked eye, the pores lying in rows; but, viewed through a good glass, every pore seems like a little fountain, with the perspiratory matter standing in it as clear as rock-water; and, if that be wiped away, more will be seen to spring up again.

When we consider the multitude of orifices all over the skin, it may be reasonably conjectured, that minute animals, as fleas, gnats, &c., do not make new perforations, but rather insinuate their slender instruments rations, but rather insinuate their slender instruments into the vessels of the skin, and suck out the blood, or what other humour is their proper aliment.

To warn the young reader of the necessity of cleanliness, a subject or two, which, if not very pleasant to discuss, may lead to effects important to future health. No animalcules are found in the saliva, but numbers of different kinds may be discovered in the whitish matter sticking between the teeth; if it be picked out with a needle or point of a tooth-pick, and mixed with a little rain-water and applied before the microscope, numbers will be visible; sometimes indeed so very numerous and active, that the whole mass appears alive. The largest sort, but few in number, move very swiftly. The second sort are more numerous, and have different motions. The third kind are roundish, and so minute that a grain of coarse sand would equal a million of them in bulk; they move so swiftly, and in such multitudes, that they seem like swarms of gnats or flies.

Some or all of these three kinds may be found constantly in the matter taken from between the teeth of men, women, and children, especially from between the grinders, even though they wash their teeth with great care. But, from the teeth of persons inattentive to cleanliness, the matter affords another sort of animalcules, in the shape of eels. They all die, if vinegar be applied; hence it has been concluded that a gargle of vinegar is good to preserve the teeth and gums from injuries these little creatures might occasion.

The microscope has discovered, what would not otherwise have been imagined, that the disorder called the *Itch*, so dreadful in its ravages among persons inattentive to cleanliness, is owing to little insects under the scarf-skin. These animalcules in shape resemble the tortoise, of a whitish colour, but darker on the back than elsewhere, with long and thick hairs issuing from it. They are very nimble in their motions, having six legs, a sharp head, and two little horns. Hence this disorder is catching, as these animalcules, by simple touch, easily pass from one person to another, having not only a swift motion, but clinging to every thing they touch, and crawling as well upon as under the outward skin; and a few once lodged, multiply apace by eggs. The infection may be propagated also by sheets, towels, handkerchiefs, or gloves; for these animalcules easily harbour in such things, and will live some days separated from the body.

The *stings* of insects are given by nature to defend from, and injure enemies. The *trunk* or *proboscis* in the mouth of gnats, fleas, and many kinds of insects, though equally sharp with the sting of wasps, bees, &c., is not intended as an instrument of revenge, but to procure and suck in their food; and, when such creatures bite or sting, it is from necessity. Squeeze or strike a bee or wasp, it instantly puts forth its sting: but no provocation can urge a flea or gnat to bite; when disturbed or hurt, they draw in, instead of thrust out, their proboscis, and use it only when they think themselves perfectly safe and quiet. There is another material difference: a sting injects a venomous liquor into the wound; but a proboscis draws out the blood and humours from it.

> With sharpen'd eye, inspect an hornet's sting,
> And all the wonders of an insect's wing. BARBAULD.

The structure and contrivance of most stings being nearly alike, to describe that of the bee, as discovered by the microscope, will be sufficient.

The sting of the bee, including two bearded darts, is a horny sheath, or scabbard that ends in a sharp point, near whose extremity a slit opens; whence, in stinging, two bearded darts protrude beyond the end; the longer one fixes its beard first, and then the other instantly, penetrating alternately deeper, holding the flesh with their hooks, till the whole sting becomes buried in the wound; then through the same sheath, from a little bag at the root of the sting, a juice is injected, which occasions acute pain, and a venomous swelling of the part, sometimes for several days.

Of the Hair of Animals;—of the Farina of Flowers; how to be examined;—of the seeds of Plants, and of the Leaves.

The *hairs* of animals differ much in appearance by the microscope, and furnish a variety of entertaining subjects. They are composed of numerous extremely minute tubes or pipes. In the hairs of some animals, spiral lines run from top to bottom, and in others transverse ones. A mouse's hairs appear in joints like the back-bone; not smooth but jagged on the sides, and terminate in the sharpest point imaginable.

NATURE DISPLAYED

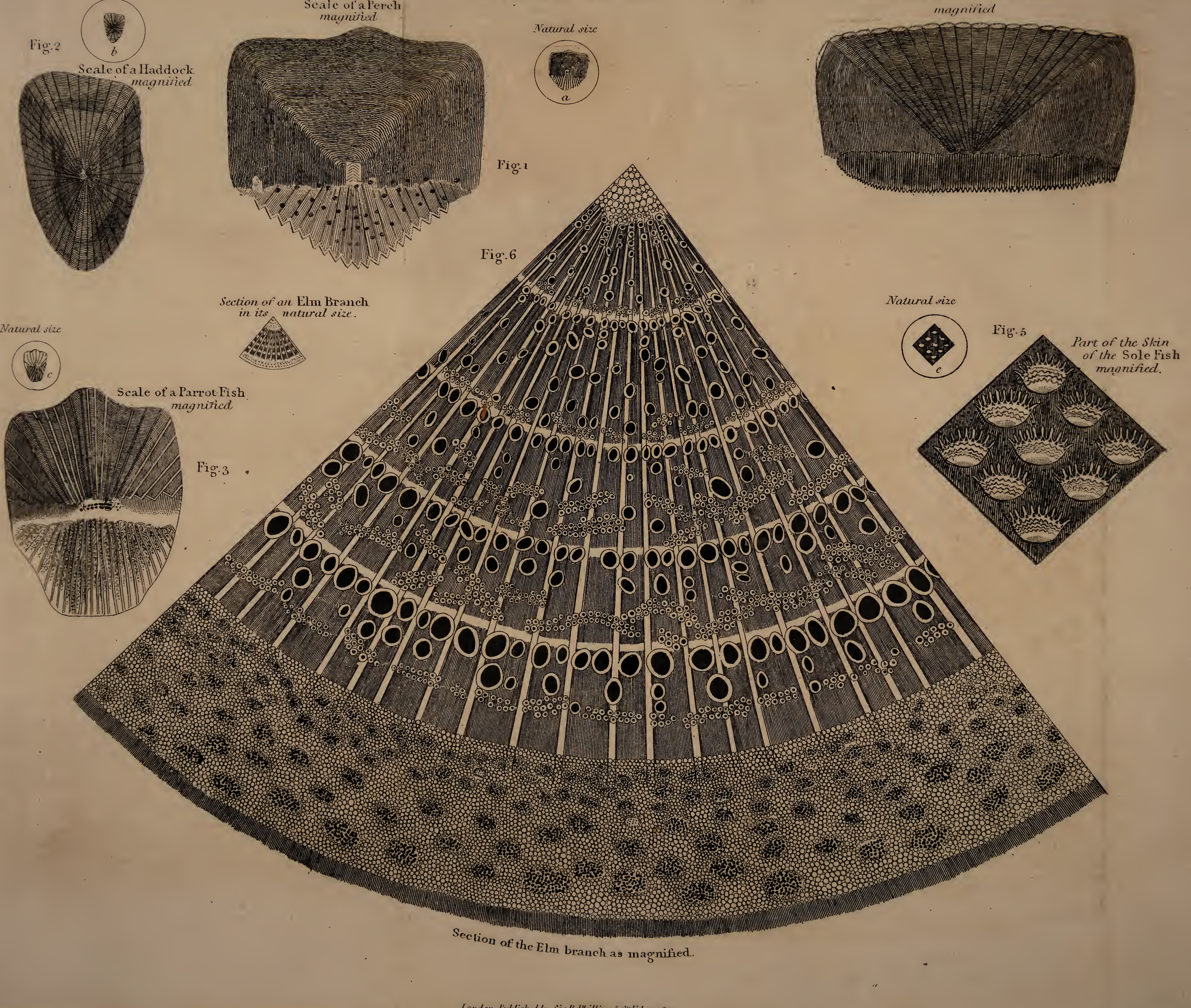


Fig. 2
Natural size
b
Scale of a Haddock magnified
Scale of a Perch magnified
Natural size
a
Fig. 1
Scale of a West Indian Perch magnified
Fig. 6
Section of an Elm Branch in its natural size.
Natural size
c
Scale of a Parrot-Fish magnified
Fig. 3
Natural size
e
Fig. 5
Part of the Skin of the Sole Fish magnified.

Section of the Elm branch as magnified.

London, Published by Sir R. Phillips & Co. Feb. 10. 1823.

Those from a mouse's belly are least opake, and fittest for the microscope.

The hairs of men, horses, sheep, hogs, &c. are composed of long tubular fibres or smaller hairs, encompassed with a rind or bark. A split hair appears like a stick shivered with beating. The roots of hair differ in shape in different animals; the hair itself is thicker towards the middle from each end.

The cat's whiskers, cut transversely, have something within like elder pitch; and a human hair, cut similarly, shews various vessels in very regular figures. Hairs from the head, eye-brows, nostrils, beard, hand, &c., appear unlike in structure and roots, and vary like plants of the same *genus*, but of different *species*.

The *farina*, or mealy powder, found on the little pendant tops of most flowers, deserves strict examination. This differs in colour in different flowers, and was formerly supposed to be unnecessary; but by the microscope all the minute grains of this powder appear regular, uniform, and beautiful little bodies, constantly of the same figure and size in plants of the same species; but differ as much in different kinds of plants as the plants themselves.

It was impossible to observe the order and configuration of the farinæ, without concluding that Providence, which never acts in vain, must intend a nobler use for such regular bodies, than to be dissipated and lost by the winds. This led to farther examination, which proved that this powder is produced and most carefully preserved in vessels contrived to open and discharge it when mature; that there is also a seed-vessel in the centre of the flower, ready to receive the minute grains, which either fall of themselves, or are blown out of their little cells; and. that on this depends entirely the fertility of the seed: for, if the farina vessel be cut away before they open, and shed their powder, the seed remains barren and unproductive.

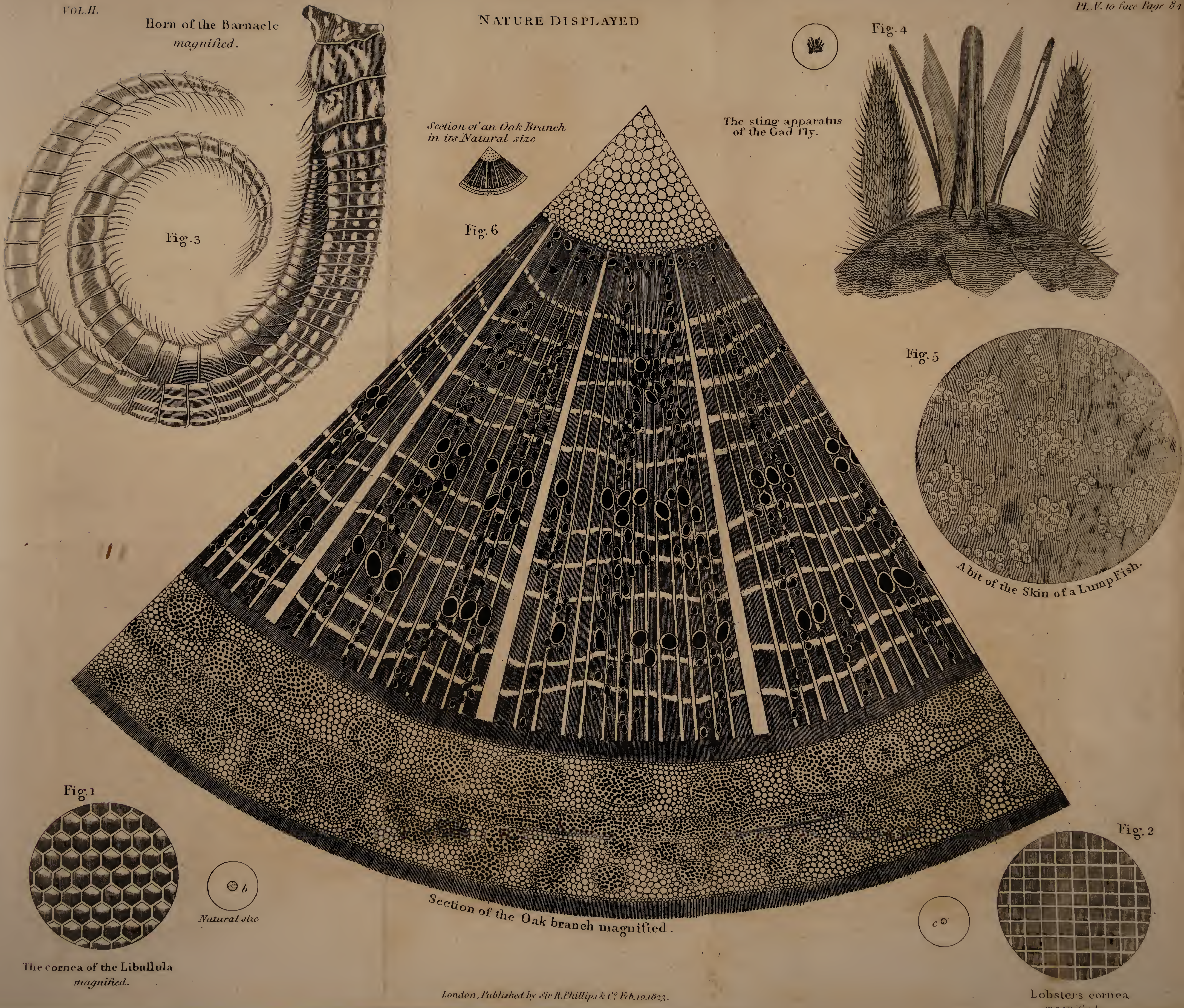
Hence this farina is supposed to be the male seed of plants; and every little grain may possibly contain a minute plant of its species. How wonderful the various contrivances of nature, to prevent this powder being unprofitably dispersed, and to assist its entrance into the prepared seed-vessel.

> ——————— in an insect or a flower,
> Such microcropic proofs of skill and power,
> As hid from ages past, God now displays,
> To combat Atheists within modern days. COWPER.

An inquisitive person will find inexpressible delight in examining and considering the varieties of farinæ discoverable in the vegetable species. In that of the mallow, each little grain appears an opake ball, with prickles issuing round it. The sun-flower farina seems composed of flat circular minute bodies, sharply pointed round the edges; the middle part is transparent, and resembles the flowers. The powder of the tulip is exactly shaped like the seeds of cucumbers and melons; likewise that of the lily; and that of the poppy appears like pearl-barley.

The farina must be gathered in a sun-shiny noon, after the dew is completely off, either shaken or with a soft hair-pencil gently brushed off upon a piece of clean white paper. A single talc or piece of isinglass breathed on, and applied to the farina, will take up some portion; it is then to be applied to the microscope; when, if the small grains are regularly spread, they should be covered cautiously with another talc, fastened with a brass wire. The talcs must not press on the farina, else they would destroy the true figure of the balls.

A collection of the most remarkable farinæ, thus preserved, will afford lasting entertainment. A diligent examination is suggested of the little cells that contain the farina, and of the other small parts of flowers; beginning with that of the blind nettle, or even the common mallow, in which will we discovered beauties not easily described; and every flower will disclose organs adapted for similar uses, though differing in form and structure. Here is an ample field for investigation, part of which is capable of leading man to the knowledge of the wonderful works of his Maker. From the farina the attention might be directed to the seed; the smallest kinds being very fit objects for the microscope; as those of lettuce, thyme, chervil,



Horn of the Barnacle *magnified.*

Section of an Oak Branch in its Natural size

The sting apparatus of the Gad fly.

A bit of the Skin of a Lump Fish.

The cornea of the Libullula *magnified.*

Natural size

Section of the Oak branch magnified.

Lobsters cornea *magnified.*

London, Published by Sir R. Phillips & Co. Feb. 10. 1823.

parsley &c. To enumerate whose beauties would be thought tedious; but the powder of the puff-ball claims a few words. This substance, crushed when ripe, to the naked eye seems like a smoke or vapour; but, when examined by good magnifiers, appears an infinite number of little orange-coloured globules, almost transparent; the axis of one is not the fifteenth part the diameter of a hair; so that a cube, whose side equals the breadth of a hair, would be equal to an hundred and twenty-five thousand.

The *leaves* of trees and plants also deserve attention, from persons in possession of a good microscope: they consist of innumerable veins and ramifications, which convey the perspirable juices discharged by the pores Leeuwenhoek reckoned in a single leaf of a species of box, above three hundred thousand pores. The leaves of rue seem full of holes, like a honey comb; all kinds of St. John's wort appear full of pin-holes; but the microscope shews those places really covered with an exceedingly thin white membrane. A sage-leaf appears like a rug, full of knots, tasseled with silver thrums, and embellished with fine round crystal beads or pendents, fastened by little foot-stalks. The underside of the sweet-briar leaf appears diapered with silver.

Leaves of stinging-nettles are thickly set with prickles, which, when touched, penetrate the skin, and cause pain, heat, and swelling. The microscope shews that these prickles are formed and act similarly to the stings of living animals, every one of them being a rigged hollow body, terminating in a very acute white point, with an opening near its end; at the bottom of this cavity, is a minute vessel, a limpid liquor, which upon the smallest touch of the prickle, is squirted through the little out-let; and, when it enters the skin, produces those painful sensations, which most persons have experienced. Hence, when the leaves of nettles are much dried, they sting little; whereas the green and juicy produce violent pain and inflammation.

LECTURE XXXIX.

Testaceous Bodies, and their Animals.

Though testaceous bodies furnish many valuable articles, scarcely any Conchologist has enumerated their different purposes of application or pointed out how their usefulness might be increased. To the savage, shells furnish important instruments. They often answer the purposes of a knife, are employed as a substitute for iron; and, with pieces of the more solid bivalves, he points his arrows, and forms his fish-hooks. Even when farther advanced in civilization, the canaliculated univalves constitute the rustic lamp, while the larger scallops are employed by the dairymaid to skim her milk, and slice her butter. From the mother-of-pearl shell, many useful and ornamental articles are fabricated; and calcined shells were formerly esteemed by physicians as absorbents; and are still regarded by the farmer as furnishing a valuable manure.

Shells thus appear of importance in the arts; but their animals are of more value. As articles of food, shell-fish are extensively used by the poor, and even hold a conspicuous place at the tables of the rich. In many places they almost support the children of our maritime population; and, in the western and northern islands of Scotland, have in years of scarcity prevented the death of thousands.

The kinds chiefly used in this country, as articles of subsistence, are bivalves, belonging to different genera. The *Oyster (Ostrea edulis)* is very widely distributed in nature, being found in the seas of Europe, Asia, and Africa. But, from the days of the luxurious Romans, the oysters of Britain have been highly esteemed. They are found from the southern shores of England, to the sheltered bays among the Shetland Islands; in a rough or rocky bottom, from five to twenty fathoms water. They are fished up with a dredge and an open boat; and, in shallow water, with a rake or tongs; and either conveyed directly to market, or placed in arti-

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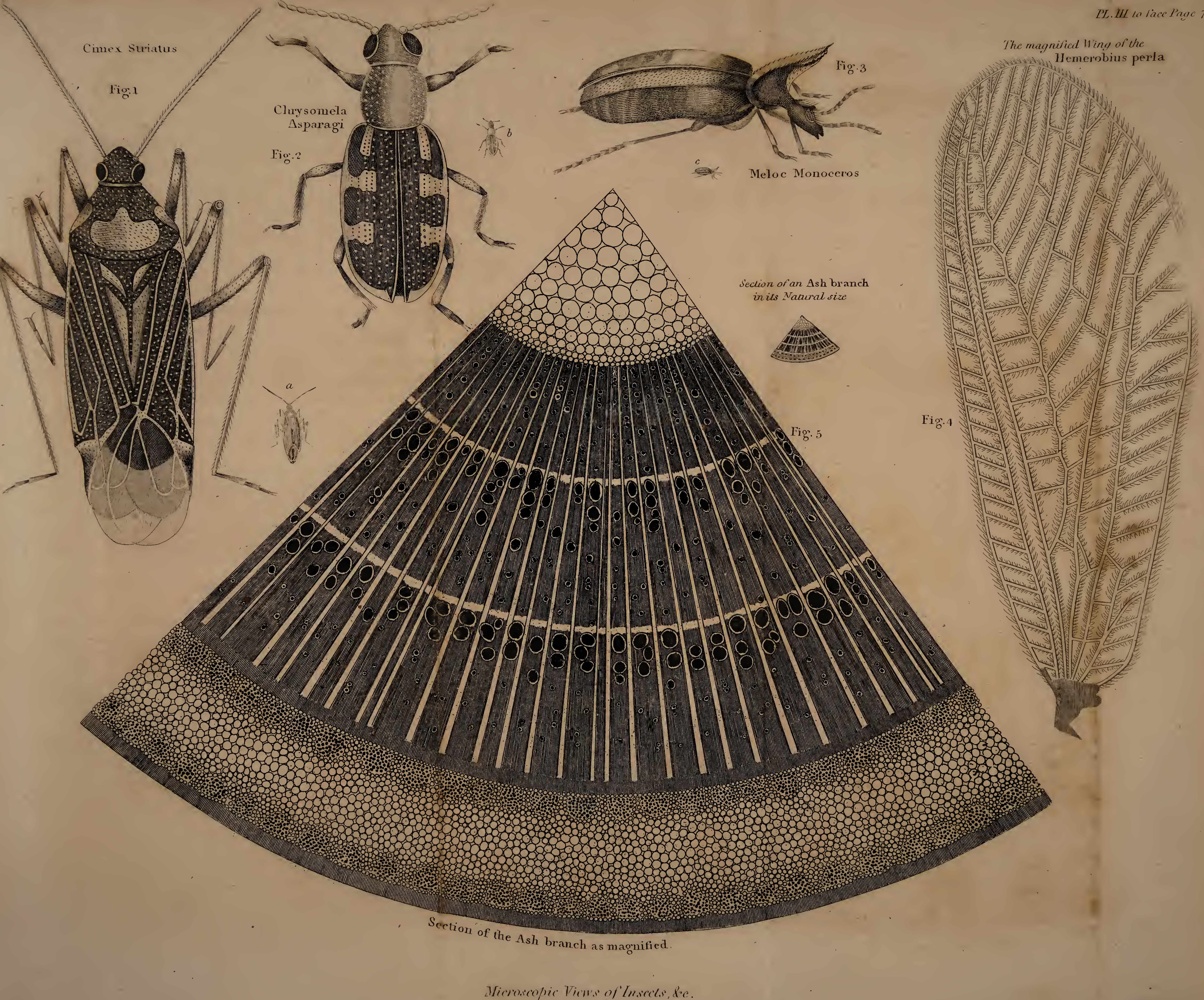
Cimex Striatus
Fig. 1
a
Chrysomela Asparagi
Fig. 2
b
Fig. 3
c
Meloe Monoceros
The magnified Wing of the Hemerobius perla
Fig. 4
Section of an Ash branch in its Natural size
Fig. 5
Section of the Ash branch as magnified.

Microscopic Views of Insects, &c.

London. Published by Sir R. Phillips & C° Feb 10 18[illegible]

ficial ponds of sea-water, where they increase in size, and acquire a fine green colour. In England, this process of *fattening*, is conducted chiefly at Colchester, with oysters obtained from the little creeks between Southampton and Chichester. This fishery, on the coast of England, employs near ten thousand people; so that, independent of its addition to the articles of subsistence, it is a valuable nursery for seamen. As food, oysters are light and easy of digestion; and great numbers may be eaten without inconvenience, either raw or when pickled. In the last form, they are sent to different parts of the country, and even exported. In Scotland, the principal oyster-fishings are in the Firth of Forth; but the proprietors of the western coast of Scotland, and the Hebrides, might propagate this shell-fish extensively on their shores and sheltered bays. Places fitted for their growth are every where to be met with; they require no superintending care; they soon furnish an esteemed dish to their tables, and form a valuable addition to their trade.

The next shell-fish of importance for food, is the *Mussel (Mitilus edulis)*, equally as widely distributed as the oyster, and found upon our coast in great abundance, in extensive beds, always uncovered at low water. It is found, likewise, in crevices of rocks In this fishery, chiefly women and children are employed, who, with an iron hook, detach the mussels from the beds or rocks to which they adhere by fine cartilaginous threads. With us they are conveyed directly to market; but, in some places of France, they are kept for a time, to fatten like the oyster, in salt-ponds, into which they admit small quantities of fresh water. The flesh is yellowish, and very rich, in autumn, when it is in season. It is eaten either boiled or pickled; seldom in soup. To some stomachs it is difficult to digest; and to many constitutions it is deleterious, in the spring, during the spawning season. This noxious quality is properly attributed to the food of the mussel, which consists chiefly of the noxious fry of the star-fish; and to a disease of the animal in spring, under which it melts away, and falls from the rocks. Besides its use to man for subsistence, the mussel supplies the fisherman with one of his most convenient and successful baits. It is keenly taken both by cod and haddock, though, to the cod-fish, the horse-mussel is more acceptable.

The *Common Cockle* (*Cardium edule*,) is exclusively confined to our sandy coasts and bays; and it is found lodged a few inches below the surface of the sand, marked by a small depressed spot. Women and children easily dig it up with a small spade. Cockles are sold by measure, and eaten either raw, or boiled, or pickled. They are deservedly esteemed a delicious and wholesome food, in this country, and are in season during March, April, and May, though in France they are little regarded.

Two kinds of *Razor-fish (Solen siliqua* and *ensis*, Scotch *Spout-fish,)* are in many places used as food. They are found upon most of our sandy shores, buried about a foot below the surface, and near the low water-mark, by a small hole in the sand. Being rather a laborious operation to dig them out, the French fishermen throw a small pinch of salt into their holes, which always remain open by the action of the respiratory organs; the fish speedily rise to the surface, and are thrown out by a proper iron instrument. The presence of the salter water, thus formed by the solution of the salt, makes the animal suppose its hole again covered with the tide. The ancients esteemed this shell-fish a great delicacy; and, boiled or fried, it is certainly very palatable. Kept for a few days, it forms an excellent bait for haddock or cod.

Several species of *Gapers (Myæ)* are used as food both in Britain and on the continent, as the *Myæ arenariæ*, whimsically named *Old Maids* by the fishermen about Southampton. These reside in the mud on the shore, a few inches below the surface. In some parts of England and Ireland, they are much used; but are never sought after, though common, in Scotland. The *Mya truncata* is also very common on the coast, in a hard gravelly bottom, near low water-mark. The inhabitants of the northern islands call it *Smuoslin*, and employ it boiled, as a supper dish. Though less delicate than some of the shell-fish noticed, it is not unpalatable. It is plentiful in the Hebrides, where it is even eaten by the gentry.

To this we may add the *Mactra solida*, used as food by the common people about Dartmouth; and the *Venus pullastra* eaten in Devonshire, and called Pullet; and known to the inhabitants of the northern islands by the name of Cullyock, and there used as a bait. The *Anomia ephippium* is used as food at Languedoc, and preferred to the oyster.

The common *Periwinkle (Turbo littoreus)* is more used as food than any of the other testaceous univalves. This shell is easily gathered, being found on all rocks left uncovered by the ebbing of the tide. Children collect the shells, which are sold by measure. They are cruelly boiled alive, and are consumed in great quantities by the poor inhabitants of the coast. The *Nerita littoralis* is frequently gathered along with the periwinkle, as it frequents the same situations; but it is smaller, and its flesh not equally good.

The *Limpet (Patella vulgata)* equally abounds with the periwinkle, and frequents the same situations. Although formerly used for food, it is seldom brought to market in this country. Among the villagers along the coast of Scotland, this shell-fish is used, and its juice (obtained by boiling) mixed with oatmeal, is highly esteemed. It is in season about the end of May. They are still to be found on Box-Hill; but their medicinal virtues are not so highly prized as in former times.—*Promenade round Dorking.*

Several species of *Snails (Helix)* are employed for culinary purposes. The largest (the *Helix pomatia)* was a favourite dish among the Romans, who fattened them with bran sodden with wine. They are used in many parts of Europe, during Lent, after being fed with different kinds of herbs. This species has been imported from Italy, to Box-Hill, in Surrey.* The *Helix hortensis* also has been employed for food; but these two species are chiefly used medicinally, and in consumptive cases. The small species of the genus are the favourite food of the birds of the thrush kind, either in a wild or confined state.

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* These snails were imported by one of the Earls of Arundel for his Countess, who ate them for a consumptive complaint.

The other univalves are of inferior importance as articles of subsistence. The *Murex despectus*, the largest British turbinated shell, is frequently dredged up with oysters, and is eaten by the poor, but oftener used for baits for cod and ray. The method of obtaining these shells for bait is ingenious, and makes us acquainted with several new habits of the animal. "At the beginning of the fishing (says Mr. Fraser,) a dog is killed and singed, and the flesh, after rotting a little, is cut into small pieces, and put into baskets made of hazel-wands, purposely. These are sunk by stones. The putrid flesh, attracts the welk, which crawls up the sides of the basket, and getting in at the top, cannot get out again, owing to its shape, like that of the wire mouse-trap. After the first day's fishing, the heads and entrails of cod, with skate and dog-fish, are put in; every day the welks are taken out, and fresh baits put in; there being no more occasion for dogs' flesh." The *Buccinum undatum*, and the *Purpura lapillus*, are also employed as bait, and in years of scarcity as food.

Independently of the food we obtain from testaceous animals, they furnish us with the *pearl*, a most beautiful ornament of dress. This substance, equally prized by the savage and the citizen, is composed, like shells, of carbonate of lime, with a small portion of animal matter. Pearls are exclusively produced by the bivalve testacea: all which shells, with a mother-of-pearl inside, produce them occasionally. But a few species yield them in greater plenty, and of a finer colour. The most remarkable is the *Avicula margaritifera*, (placed by Linnæus among the mussels,) very widely distributed in the Indian seas; and from it the species *Avicula Hirundo*, of the European Seas, are the pearls of commerce procured. The *Pinna*, famous for furnishing a byssus or thread, with which garments can be manufactured, likewise produces pearls of considerable size, but seldom with the silvery whiteness of those from the Avicula; being usually tinged with brown. The shell which in Britain produces the finest pearls is the *Unio margaritifera*, found in all our alpine rivers: the Conway and Irt, in England; the rivers of Tyrone and Donegal, in Ireland; and the Tay and Ythan, in Scotland. They are found between the membranes of the cloak of the animal, in the Avicula; or adhering to the inside of the shell, in the Unio. They seem, in the former, a morbid secretion of testaceous matter; in the latter, matter accumulated against the internal opening of some hole with which the shell has been pierced by an enemy. Linnæus, from this consideration, endeavoured, by piercing the shell, to excite the animal to secrete pearl; but his attempts, though they procured him a place among the Swedish nobility, and a pecuniary reward, were finally abandoned; the process being too tedious and uncertain to be of public utility. The largest pearl known came from Panama, and was presented to Phillip II. King of Spain, in 1579. It was of the size of a pigeon's egg. Sir Robert Sibbald mentions pearls from the rivers of Scotland as large as a bean.

Besides yielding a variety of wholesome food, and valuable ornaments, testaceous animals supply a beautiful *dye*. The *Purpura* of the ancients was extracted from the *Murex brandaris*. Since the introduction of cochineal, this dye has been superseded, so that we are almost ignorant of the process employed to extract it. In Britain several kind of shell-fish furnish a dye of this sort, but these are seldom sought. Cole, in 1685, published a method of obtaining it from the *Purpura lapillus;* and Montagu, in the Supplement to *Testacea Britannica*, has added several important directions. When the shell is broken in a vice, there is seen on the animal's back, under the skin, a thin longitudinal whitish vein, containing a yellowish liquor; which, applied to linen, by a small brush, and exposed to the sun, becomes green, blue, purple, and at last settles in a fine unchangeable crimson, not affected by acids or alkalies, and convenient for making linen, where an indelible ink is desirable. The *Scalaria clathrus (Turbo clathrus* of Linnæus) also furnishes a purple liquor of considerable beauty; but destructible by acids, and gradually vanishing by the action of light. The *Planorbis corneus* likewise yields a scarlet dye, but less permanent than the scalaria; all attempts to fix it having hitherto proved ineffectual.

The animals belonging to shells divide themselves into two great divisions. The first, termed *Mollusca cephala*, have a head, with eyes, and even ears, in some of the groups. The other, *Molusca acephala*, contains animals less perfect in organization, without head, vestiges of eyes, or ears.

It is most important, in the arrangement of natural bodies, to have an exact idea of the relative value and true subordination of the characters used. We consider that character as of the highest kind which has the greatest influence over the faculties and instincts of the animal. To ascertain, in some degree, this subordination of character, is the object of the following observations.

The divisions of bivalves and univalves are both obvious and natural. They indicate the existence of certain forms peculiar to the animals whose shells are thus separated. The univalve shells are inhabited by animals with a head, and whose organs of motion are either tentacula, situated on the head, or a foot spread over the belly, as in the slug. The animals of the bivalve shells are destitute of a head; some without locomotive power; in others, the organ of motion is a fleshy foot, protrusive at pleasure.

It is difficult to point out, among the univalves, the true subordination, or relative importance, of the characters. Having much to learn of their anatomy, we cannot with certainty point out the relation of the parts of the shells to the organs which those parts protect. The form and structure of the mouth, however, furnish characters of first-rate importance; and on its form, the very shape of the animal, together with its ordinary habits, in a great measure depend.

In many genera, the mouth of the shell, towards the base, is produced, and terminates in a groove or beak. These univalves, called *canaliculated*, are readily distinguished from those whose mouth is *entire*. Their difference in the form of the shell is an index of equally remarkable differences in the form of the animals. The first contain animals possessing an elongated tube for respiration, with this canal for its reception, and protection when expanded. The animals whose shells want this canal, are destitute of this respiratory tube. Such circumstances induce the belief, that shells, agreeing in external form, in general, contain animals of similar organization.

The next important character depends on the direction of the spiral revolutions. When a spiral univalve is placed upon its base, or mouth, with its summit towards the observer, the mouth opens on the right side of its axis or pillar, and the whorls revolve from right to left, from the base to the summit. Such shells are called *dextral.* In a few shells, however, this is reversed. The mouth occurs on the left side of the pillar, and the whorls revolve from left to right. The shells are called *sinistral,* also heterostrophe, or heteroclite, and generally by dealers *unique.*

Among many of the univalves, the animal has a lid to close up the entrance, after it has withdrawn into the cavity of the shell; generally corneous, sometimes calcareous, usually flat, and attached to the superior and posterior part of the animal's foot. These shells are called *operculated.* They are distinct from those land-shells whose animals form a temporary covering to the mouth, to protect them from the vicissitudes of winter. In the former, it is permanent, and it adheres to the animal; in the latter, deciduous, adhering only to the margins of the mouth of the shell.

Among univalve shells is considerable difference in the shape and position of this cavity, which is conical, in others conico-tubular, either revolving horizontally round a centre, or spirally twisted upon an axis. These circumstances, aided by the structure of the pillar, and the direction of the whorl, furnish characters by which all testaceous bodies may be arranged into two tribes:—the one possessing a pillar, round which the tube of the shell is twisted; the other destitute of any pillar. The former are called *Stulidia,* the latter *Astulidia.*

The last character to be noticed, while speaking of the univalves, depends on the cavity being entire (*unilocular*), or divided into chambers (*multilocular*). In the multilocular testacea, a number of transverse plates, in some species perforated, in others entire, cross the cavity of the shell, and divide the external cavity, in which the animal resides, from the older and smaller ones, whence it has receded.

These preceding remarks apply to the cephalous mollusca shells. Among the bivalve shells, which belong to the acephalous mollusca, the characters are of different degrees of importance. Here, also, the appearance of the shell suggests an idea of the organization of the animal.

The bivalve shells, in general, possess the faculty of changing place, or of attaching themselves to rocks and stones, by temporary threads. These are called *free* shells. But others secrete at their birth a calcareous cement, which for life immoveably unites the shell to the rock or stone. These are called *fixed* shells. If we thus consider the different economy of these two divisions, we find corresponding difference in organization. The free shells contain animals endowed with locomotion, and, by consequence, with feet. In few of the animals which inhabit fixed shells, can a foot be observed. The latter are more simple in their organization,—are without absorbing or ejecting syphons, these being supplied by holes in the duplicature of the cloak. This last distinction, however, is not peculiar to, though found in all, the fixed shells.

Among the free shells some adhere to rocks and stones by temporary threads produced by the animal. They are called *byssiferæ*. Independent of the utility of this power of producing threads of attachment to the economy of the animals, the byssiferæ possess at least three organs which the other testaceous mollusca want. The first is, a gland to secrete the substance of the threads; the second, a foot capable of spinning and fixing these threads to rocks or other bodies; and the third is a muscle capable of contraction and elongation, to which the inner end of these threads may be attached.

In general, but not always, the valves of the shell close upon each other so as to leave no opening. In a few genera, the point of union is at one side or in the middle. The former are called *close*, the latter *gaping*, shells. The obvious character of gaping is an index of equally important distinctions in the animal. In the *gapers*, the absorbing and ejecting syphons are two, very long and often united. The foot is in a sheath, whence it issues at pleasure. Besides, the branchiæ are always united, and as long as the tubes.

When the two valves have the same size and form, the shell is called *equivalve*; but, when they differ, the shell is called *inequivalve*. This character is not the index of any peculiar organization of the animal. The inequivalves, however, are mostly irregular in their growth. The molluscous inhabitants have no lengthened syphon nor foot.

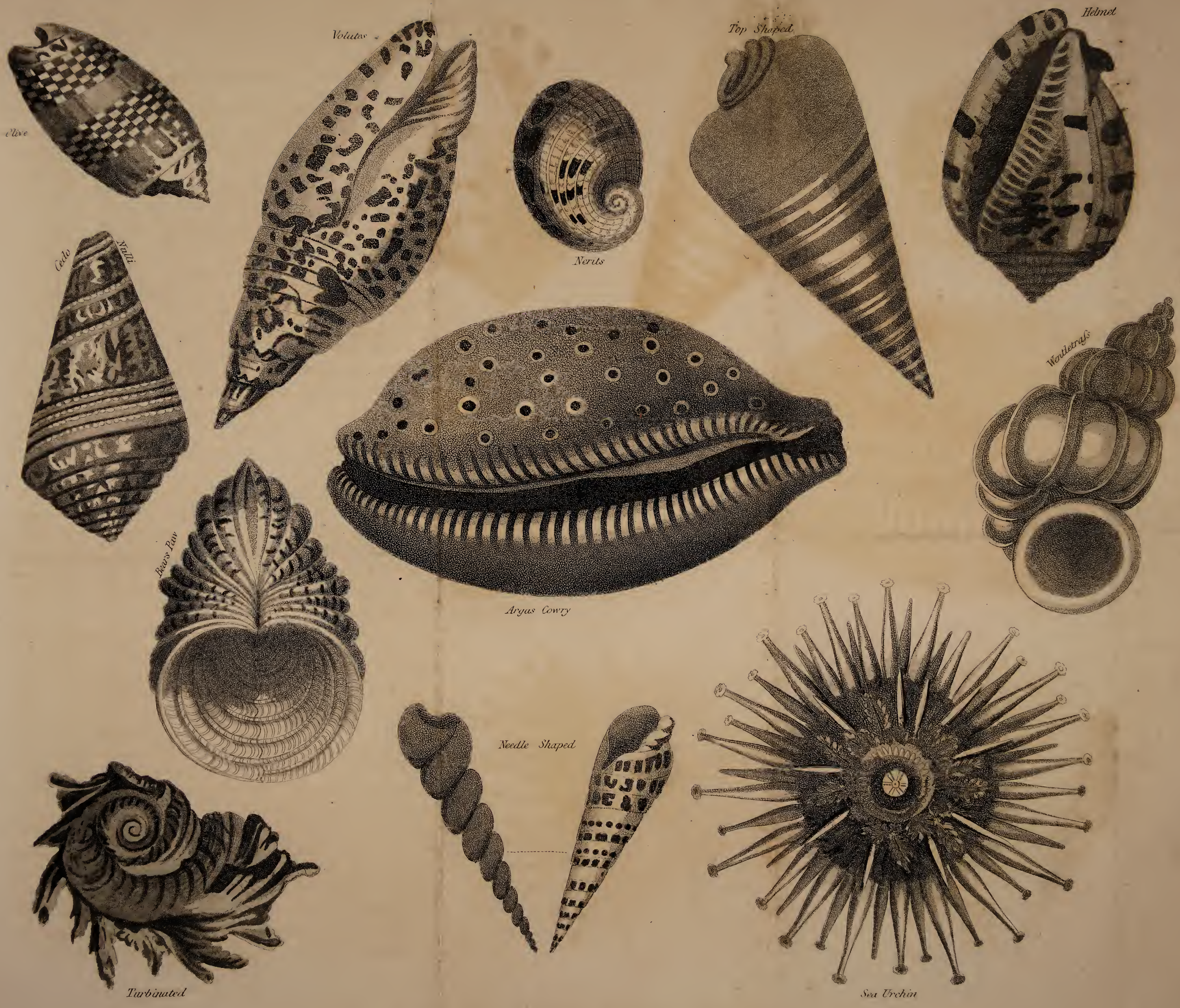
The inner surface of bivalves have some spots in colour and lustre different from the general surface. To these places adhered the muscles which connected the animal with the shell, and are called *muscular impressions*. They are either separate and lateral, subcentral, simple, or composite.

Intimately connected with the muscular impressions is the *ligament*,—a horny elastic membrane, to open the valves, when the adductor muscle relaxes; in some shells it is placed on the exterior margin, in others it is concealed. When external, it is stretched, and, when internal, it is compressed when the shell is closed.

The *teeth* of the hinge of bivalves do not appear to be the index of any peculiar organization. The use of the adductor muscle is to close the shell; the ligament opens it: and the teeth of the hinge modify and direct these movements. The characters furnished by these three parts if the shell appear of nearly equal importance.

The last character of the bivalves is the power some possess of piercing stones and wood to form a retreat: these are called *borers*. Many supposed that the animal secreted a liquor which dissolved the bodies into which it penetrated; but Reaumur ascertained the boring was performed by a rotatory movement of the larger valves. M. Fleurieu-Bellevue states, that the calcareous stone, wherein the *Rupellaria lithophaga* is found, is often discoloured in the immediate neighbourhood of its recess, but this may arise from other secretions of the animal, or even from the stagnant sea-water in the hole, and not from the action of phosphoric acid or any other solvent supposed to be employed by the animal; as these would act as much on the shell as on the calcareous rock. The borers are not confined to calcareous rocks; they also lodge in slate-clay, and other argillaceous strata. This is

Shells



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very often the case with the Pholades. The same species at one time may be found imbedded in stone, at another seated among the roots of sea-weed, or buried among gravel.

Another class of characters is from the situation in which shells are found; whether on the land, in fresh water, or in the sea. Nature has drawn a line of separation between the three tribes not difficult to be perceived.

The terrestrial testacea live on vegetable matter; and their organs of respiration are suited to their residences. Their organs of feeling are more numerous than those of the marine shells. The tentacula of the latter seldom exceed two, whereas in the land-shells they are four in number. The eyes are differently placed; in the aquatic testacea they are on the head, at the base of the tentacula; whereas, in the terrestrial species they are on the tips of these organs. No bivalve shells are found in the land,—they belong exclusively to fresh water, and to the sea.

The fluviatile shells, though residing in a medium different from the terrestrial, have their organs of respiration nearly the same; and therefore come occasionally to the surface to respire. They have two flat tentacula, with the eyes at the base. They may be distinguished from the marine kinds, by the superior thickness of their epidermis,—their corneous colour, and semi-transparency.

The marine shells are the most numerous, the most beautiful, and the most highly prized. Many of the univalves possess a lengthened respiratory tube, with a protecting canal in the shell; a circumstance not observed in the fluviatile testacea. One circumstance points out the difference in structure between the fluviatile and marine testacea: the fluviatile cannot live in salt-water, nor the marine in fresh water.

Mollusca Cephala.—Head distinct from the body, bearing the lips or jaws; the head, or anterior part, possesses freedom of motion, and the dorsal aspect supports either tentacula or eyes, frequently both. The animals exhibit many modifications of form and structure, in all the series of organs; and easily admit, therefore, of subdivision into inferior groups, which exhibit well-marked distinctive characters. Two of these groups occupy a primary rank, and admit the others as subordinate sections. In the first the animals all inhabit the water, and progressive motion through that element is performed by organs fitted for swimming; and they are destitute of any ventral disc on which to crawl. The second group includes animals which inhabit the land, and also those which live in fresh water and in the sea, and whose progressive motion is by crawling along the surface of objects, the body resting on a ventral disc, termed a foot.

The organs of progressive motion fitted for swimming are situated near the anterior extremity of the body, and consist either of flexible tentacula, or membranaceous expansions. All the species reside in the sea, and have nearly the same specific gravity as the fluid in which they float, having their motions greatly regulated by its changes. It is probable, however, that, by some contractile movements, they can vary their density, and rise or sink in the water. They swim slowly, even with their utmost efforts.

In the cephalopoda class, the fins are in the form of tentacula, surrounding the mouth. In cephalopodous animals the body is surrounded by a sac or tunic, closed posteriorly, and part open anteriorly, for the orifices of the several organs: this tunic differs greatly in texture, and is strengthened internally by testaceous or corneous productions, or externally by a spiral shell. The neck is distinct from the sac. The head is flattened into a disc, in whose centre is the mouth, and towards the margin the tentacula. The Nautilus and Sepia comprehend all the animals.

LECTURE XL.

NAUTILUS.

Learn of the little Nautilus to sail,
Spread the thin oar, and catch the driving gale.

The shell consists of one spiral valve, divided into several apartments by partitions, perforated by a tube; the turns of the spire are contiguous, and the last whorl encloses the others, hence called multilocular. Many recent species have, by microscopic aid, been discovered among the sand on the sea-shore; and a greater number in a fossil state among the calcareous strata.

Bonant observes, that this genus of shell-fish is very well named from a Greek word, which signifies both "a ship" and "a sailor;" for that the shells of all the nautili carry the appearance of a ship with a very high poop. It is by some imagined, that men first learned the art of navigation from this animal.

The most remarkable division of the nautili is into the thin and thick-shelled kinds. The first is called *Nautilus papyraceous;* and its shell when out of the water is indeed no thicker than a piece of paper. This species is not at all fastened to its shell; but there is an opinion, as old as the days of Pliny, that this creature creeps out of its shell, and goes on shore to feed. When this species is to sail, it expands two of its arms on high, and between these supports a membrane, thrown out on this occasion, which serves for its sail, and the two other arms it hangs out of its shell, to serve as oars, and the office of a steerage is generally served by the tail. When the sea is calm, numbers of these creatures are seen thus diverting themselves; but when a storm rises, or any thing disturbs them, they draw in their legs, take in as much water as makes them specifically heavier than that in which they float, and then sink to the bottom. When they rise again, they void this water by numerous holes, of which their legs are full.—The other nautilus, whose shell is thick, never quits that habitation. This shell is divided into 40 or more partitions, which grow smaller as they approach the extremity or centre: between every cell and those adjoining, is a communication by a hole in the centre of every partition, through which runs a pipe the whole length. Some have supposed that by this pipe the fish occasionally passes from one cell to another; but this seems improbable, as the fish must be crushed to death by passing through it. It is more likely that the fish always lives in the largest chamber in its shell, the cavity between the mouth and the first partition, and never removes out of this; and that the cells, and pipe of communication, so much admired, serve only to admit, occasionally, air or water into the shell, in such proportion as may serve the creature in its intentions of swimming.

Some have called this shell the *Concha margaritifera;* but this can be only because of the fine colour on its inside, more beautiful than any other mother-of-pearl; but this species never produced pearls.

It must be observed, that the polypus is by no means to be confounded with the paper-shelled nautilus, notwithstanding the great resemblance in the arms and body of the inclosed fish; nor is the cornu ammonis, so frequently found fossile, to be confounded with the thick-shelled nautilus, though the concamerations and general structure of the shell are alike in both; for there are great and essential differences between all these genera.

The *Cuttle Fish (Sepia).*—Destitute of a multilocular shell: the sac is furnished with fin-like expansions, and strengthened internally by corneous or testaceous ribs or plates. There are eight brachia or arms interspersed on the interior side with little round serrated cups, by the contraction of which the animal lays fast hold of any thing Besides these eight arms, it has two feet, nearly similar in their structure to the arms, or tentacula, but considerably larger in their dimensions. They have their organs on the ventral side of the mouth, between that organ and the funnel. The suckers are pedunculated, with their margin strengthened by a corneous ring, furnished with teeth. The head is divided from the sac on all sides by a neck. The margin of the anus is surrounded with tentacula. The mouth is situated in the centre of the arms, and is horny, and hooked like the bill of a hawk; the eyes are below the tentacula, towards the body of the animal; the body is fleshy, and received into a sheath as far as the breast; their food are tunnies, sprats, lobsters, and other shell fish. With their arms and trunks they fasten themselves, to resist the motion of the waves. The females are distinguished by two paps; they copulate like the polypi, by mutual embrace, and lay their eggs upon sea-weed and plants, in parcels like bunches of grapes. Immediately when laid they are white, and the males pass over and impregnate them with a black liquor, after which they grow larger. On opening the egg, the embryo-cuttle is found alive. The males are very constant, ever accompany their females, face every danger in their defence, and rescue them intrepidly at the hazard of their own lives. The timorous females fly as soon as they see the males wounded. The noise of a cuttle-fish, on being dragged out of the water, resembles the grunting of a hog. When the male is pursued by the sea-wolf or other ravenous fish, he shuns the danger by stratagem. He squirts his black liquor, sometimes to the quantity of a dram, by which the water becomes black as ink, under shelter of which he baffles the pursuit of his enemy.

This ink or black liquor has been denominated, by Le Cat, *æthiops animal,* and is reserved in a particular gland. As a liquor it resembles the choroid in man; and would then communicate an indelible dye; when dry, it might be taken for the product of the black liquor in negroes, dried, and made precipitated by spirit of wine. This æthiops animal, in negroes, as well as in the cuttle-fish, is more abundant after death than even during life. It may serve either for writing or printing; in the former way the Romans used it. It is said to be an ingredient in the composition of Indian ink, mixed with rice.

In the *Sepia,* the sac is furnished on each side throughout its whole length with a narrow fin; the suckers are irregularly scattered on the arms and feet; the back is strengthened by a complicated calcareous plate, lodged in a peculiar cavity. This plate has been long known in the shops under the name *Cuttle fish bone,* formerly used as an absorbent, and belongs to the species *S. officinalis.* The bones are frequently flung on all our shores; the animal very rarely. The conger eels bite off their arms, or feet; but they grow again, as does the lizard's tail. They are preyed upon by the plaise. This animal was esteemed a delicacy among the ancients; and is eaten even at present by the Italians. Rondeletius gives us two receipts for the dressing. Athenæus also leaves us the method of making an antique cuttle-fish sausage; and we learn from Aristotle, that those animals are in highest season when pregnant.

The bone of the cuttle-fish is hard on one side, but soft and yielding on the other; so as readily to receive pretty neat impressions from medals, &c. and afterwards to serve as a mould for casting metals, which thus take the figure of the original: the bone is likewise frequently employed for cleaning or polishing silver. The particular qualities of the black liquor in the cuttle fish are not yet determined. Dr. Leigh says, he saw a letter which had been written with it ten years before, and which still was legible. Some report that the ancients made their ink from it; and others, that it is the basis of China, or Indian-ink; but both these accounts have little foundation. Pliny, speaking of the inks made use of in his time, after observing that the cuttle-fish is in this respect of a wonderful nature, adds expressly, that ink was not made from it.

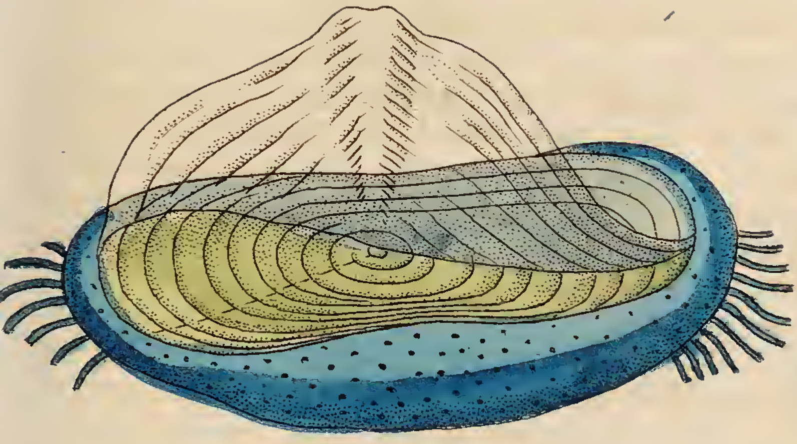
The *Loligo,* or great cuttle,—with short arms and long tentacula; the lower part of the body rhomboid and pinnated, the upper thick and cylindric; sides of the sac only furnished partially with fins; the suckers are disposed on the arms and feet in a double row; the dorsal plate is flexible and corneous, imbedded in the substance of the sac, and is multiplied with ears. They inhabit all our seas, where having blackened the water by the effusion of their ink, they abscond, and with their tail leap out of the water. They are gregarious and swift in their motions: they take their prey by their arms, and, embracing it, bring it to their central mouth. They adhere to the rocks, when they wish to be quiescent, by the concave discs placed along their arms.

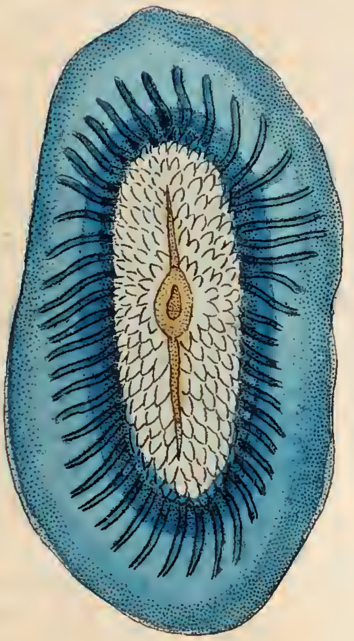
The *Octopodia,*—with eight arms, connected at their bottom by a membrane; the suckers have soft margins; the sac is destitute of fin-like expansions, and is either simple or strengthened in the interior by two short corneous processes; the head is united with the sac behind, without the intervention of a neck; the suckers are sessile, arranged in a double row; the oviduct is double; and the margin of the anus is simple. This is the polypus of Pliny, by him distinguished by the want of the tail and tentacular. They inhabit our seas, but are at home in the Mediterranean. In hot climates they are of an enormous size. The Indians affirm that some have been seen two fathoms broad over their centre, and each arm nine fathoms long. The Indians navigate their little boats in dread of them; and lest the animals should fling their arms over and sink them, they ever sail with an ax to cut them off. When used for food, they are served up red from their own liquor, which, from boiling with nitre, becomes red. Barthol says, upon cutting one of them open, so great a light broke forth, that at night, upon taking away the candle, the whole house seemed to be in a blaze.

The *Media*, or middle cuttle,—has a long, slender, cylindric body; sail finned, pointed, and carinated on each side; two long tentacula; the body almost transparent, green, but convertible into a dirty brown; confirming the remark of Pliny, that they change their colour through fear, adapting it, chameleon-like, to that of the place they are in. The eyes are large and smaragdine. The *Sepiola*, or small cuttle, with a short body, rounded at the bottom, has a round fin on each side and two tentacula. They chiefly inhabit the Mediterranean. Two of the arms at their inner extremities furnished with membranaceous expansions. The suckers are in a double row, and supported on footstalks. In the specimens of the *Ocythoe Cranchii*, procured during the expedition to the Congo, Dr. Leach observed four oblong spots on the inside of the tube, resembling the surfaces for the secretion of mucus, two inferior and lateral, and two superior, larger, and meeting anteriorly. On the rim of the sac, immediately above the branchiæ, on each side, is a small, short, fleshy tubercle, which fits into an excavation on the opposite side of the sac. This animal was long considered as the fabricator of the shell termed Argonauta or Paper Nautilus. The observations, however, of Mr. Cranch, demonstrate that the shell is merely the temporary residence of this animal, which it quits at pleasure. On the 13th of June, he placed two living specimens in a vessel of sea-water; they very soon protruded their arms, and swam on and below the surface, having all the actions of the common *Polypus* (octopus) of our seas; by their suckers, they adhered firmly to any substance with which they came in contact, and when sticking to the sides of the basin, the shell might easily be withdrawn from the animal. They had the power of completely withdrawing within the shell, and also leaving it entirely. One individual quitted its shell, and lived several hours swimming about, and showing no inclination to return into it; and others left the shells as he was taking them up in the net. They changed colour, like other animals of the class Cephalopoda; when at rest the colour was pale flesh-coloured, more or less speckled with purple; the under parts of the arms were bluish-grey; the suckers whitish. The specimens were met with in the Gulf of Guinea, and afterwards on the voyage, swimming in a small argonauta, on the surface of the sea.

Pulmonifera.—The pulmonary cavity is single and lateral; its orifice is capable of being closed at will; the blood-vessels are spread, chiefly on the walls and roof, like delicate net work.

Sir Everard Home, treating of the distinguishing characters





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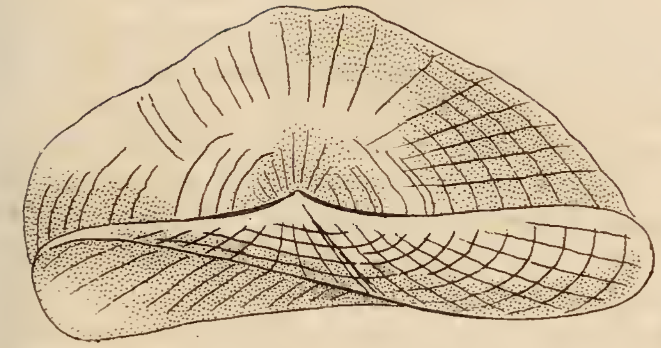

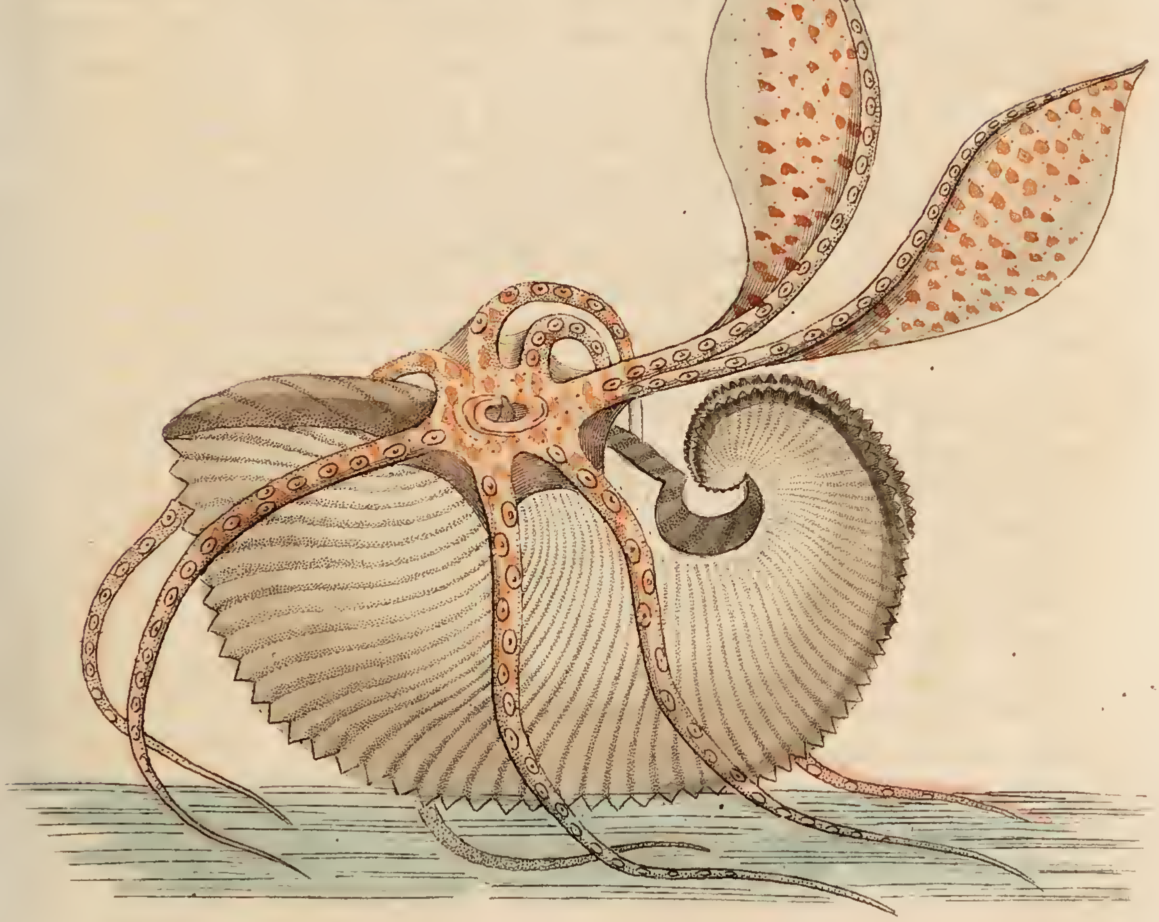

ARGONAUT OR PAPER NAUTILUS.

Neele & Son. 352 Str

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between the ova of the sepia, and the vermes testacea, that live in water, referring to the latter, says, " If the shell were formed in the ovum, the process of aërating the blood must be very materially interfered with, for this reason, the covering, or shell of the egg, first drops off, and the young is hatched before the shell of the animal is formed ; this I have seen take place in the eggs of the garden snail ; but in the testacea that live in the water, the young requires some defence in the period between the egg being hatched and the young acquiring its shell, which is not necessary in those that live on land ; for this purpose, the ova are enclosed in chambers of a particular kind."—*Phil. Trans.* 1817, p. 297. This assertion, founded on *a priori* considerations, that the shell is not formed until after the egg is hatched, is opposed by every observation on the subject ; and at variance with his own observations on the garden snail ; the very example produced in confirmation. The eggs of a snail, laid August 5, 1773, were hatched on the 20th, and their condition distinctly stated :—" On the 20th, the young were hatched, and the shells completely formed." It is more becoming, in a philosopher, to observe how nature operates, than to pronounce what she *must* do.—*Sup. Ency. Brit. Art. Mollusca.*

Terrestrial.—The animals of this order reside constantly on the land. When by accident they fall into the water, they appear incapable of using their foot as a sucker, or fin, and die after a few writhings. The species prefer moist places, and seldom are active in dry weather. After a shower they quit their hiding-places, and then may be readily collected. The eggs are hatched on land.

Cloak and foot parallel, and containing the viscera between them. In this group are included those animals denominated slugs in this country. They possess four retractile tentacula, of unequal length ; the eyes are two in number, in the form of black points, seated at the tips of the posterior tentacula.

The Arion.—A mucous orifice at the termination of the cloak. The species were formerly confounded with those of the Limax. It differs, however, in possessing the mucous pore, in the pulmonary orifice being near the anterior margin of the shield, with the sexual orifice underneath, and in the soft state of the calcareous matter in the shield.

The Limacellus.—Pulmonary orifice near the anterior margin of the shield.—M. de Blainville made observations on a specimen in a shrivelled state, preserved in spirits of wine, communicated from Dr. Leach, of the British Museum. The animal is rounded before, pointed behind, and dorsally protuberant. The whole body is smooth, soft, and of a greyish white colour. The shield, which adheres on all sides, is destitute of any shelly plate ; notched near its anterior margin, at the opening of the pulmonary cavity. The foot is broad, and separated from the cloak by a slight fold, which, on the right side, forms a groove, leading from the base of the right tentaculum to the posterior extremity of the body; whence it is inferred, that the sexual organs are disjoined, the female parts being seated in the tail, while the male organs occupy the ordinary position. The only species, *Limacellus lactescens*, is supposed to have been brought from the Antilles. In the *Parmacella*, from Mesopotamia, the shield is placed nearer to the tail than in the preceding, and is fortified internally with a subspiral plate. The posterior extremity of the shield contains the shell; the pulmonary cavity is underneath the shell of the shield; which arrangement occasions a corresponding posterior position to the heart. Along the back, from the shield to the head, are three grooves, the middle one double. The shield adheres only at the posterior portion, the anterior part being free. The internal structure is similar to the slugs; the only marked difference consists in two conical appendages of the sexual cavity, by which there is an approach to the *Helices.*

In the *Snail* the cloak and foot are parallel; the viscera contained in a spiral dorsal protuberance, protected by a shell.

This includes the animals usually denominated Snails: they bear a very close resemblance to the slugs. The shield, however, has a thickened margin in front, destined to secrete the matter of the shell. In the part corresponding with the centre of the shield in the slugs, there is a *natural rupture,* through which the viscera protrude into a conical bag twisted spirally, which contains the principal viscera, the liver occupying its extremity. The body is attached to the pillar of the shell by a complicated muscle, which moves with the growth of the animal. The mouth has above a thin-arched corneous mandible, notched on the edges. The whole body, including the foot and head, are capable of being withdrawn into the cavity of the shell. In one genus, the aperture is closed by a lid.

The *Snail Helix.*—Last formed whorl of the shell greatly larger than the penultimate one. Aperture of the shell lunulated; the width and length nearly equal. In all this division, the margin of the shell, while the animal is young, is thin; but upon reaching a certain period, it becomes thick, and bordered with a ring, after which there is no increase of size. Snails differ from the slugs chiefly in the organs of reproduction. The vagina, previous to its termination in the sexual cavity, is joined by the canal of the vesicle, and by two ducts, each proceeding from a bundle of multifid vesicles. Each bundle consists of a stem or duct, and numerous branches. with blunt terminations. These organs secrete a thin milky fluid, whose use is unknown.

The *Wreath (Turbo).*—Last whorl nearly of the same size as the penultimate one, or even less. The animal is of the snail kind; the shell consist of one spiral solid valve, and the aperture is orbicular. Aperture of the shell destitute of thickened margin; and some of the shells are much valued. There is in this group no certain indication of maturity or stationary growth. 1. The periwinkle *(littoreus).*—This is abundant on most rocks far above low water mark. The Swedish peasants believe, that when these shells creep high up the rocks, they indicate a storm from the south. They are eaten by the poor people in most parts of the kingdom. Young lobsters are said to take up their lodging in the empty shells of these animals, which has caused an opinion, that periwinkles are changed into lobsters. 2. The *clathrus*, or barbed wreath, has a taper shell of eight spires, distinguished by elevated divisions running from the aperture to the apex. There is a variety pellucid, with very thin edges. It is analogous to that curious and expensive shell, the *wentle-trap.*

The *Segmentina, or Nautilus lacustris,*—has the cavity of the shell divided. Externally, the shell appears similar to planorbis; but, internally, it is divided by testaceous transverse partitions into several chambers, which communicate by triradiated apertures. It is uncertain whether the animal is dextral or sinistral.

In the *Peronia,* the body is destitute of the external protection of a shell; the head has two long retractile tentacula; the snout is divided into two broad appendages. Between the tentacula is the opening. The anus is terminal, above which is the entrance to the pulmonary cavity; and on the right is the opening to the female organs, from which a groove runs towards the right lobe of the snout. This was found creeping upon marine rocks, under water, at the Mauritius, by Peron. Cuvier conjectures that it breathes free air, and has accordingly inserted it among the *Pulmones aquatique.* Some doubts, however, may reasonably be entertained about the truth of this supposition. It would certainly be an unexpected occurrence to find a marine gasteropodous mollusca coming to the surface at intervals to respire. It probably is truly branchiferous.

Branchifera.—The molluscous animals of this class are more numerous than those of the preceding. They chiefly inhabit the waters of the ocean, a few genera only being met with in fresh water lakes and rivers. The branchiæ, which constitute their aërating organs, exhibit numerous varieties of form, position, and protection, and furnish valuable characters for methodical distribution. In those which have the branchiæ external, they are pedunculated, and more or less plumose; moveable at the will of the animal, and capable of great alteration of form. In nearly all the genera the branchiæ are numerous, and distributed regularly over the cloaks or sides. In many species the body is exposed, and destitute of a shell; the branchiæ issuing from the cloak dorsally; the back is covered with perforated papillæ, which pour out a mucous secretion. All the species are hermaphrodite, with reciprocal impregnation. Anus situate near the posterior extremity of the back, and surrounded with a fringe of plumose branchia.

The *Doris.*—Oral tentacula two; vent without scales. The cloak is covered with retractile papillæ, and separated from the foot by a distinct duplicature. Towards its anterior margin are the two superior tenticula, retractile, surrounded at the base with a short sheath, and supported on a slender stem, having an enlarged compound plicated summit. The neck is short, and above the mouth is a small projecting membrane, connected at each side with the oral tentacula, in general minute, and of difficult detection.

The *Montagua.*—Tentacula four in number. The branchiæ are simple, tapering, or clavate, and disposed in transverse rows on each side. These branchiæ in some species readily fall off, and are capable of swimming about in the water for a short time, as if independent. This is executed by minute hairs with which their surface is covered, and which move rapidly, pushing forward the distal extremity. Branchiæ in continuous rows across the back. This differs from the other not merely in the arrangement of the branchiæ, but in possessing a cluster of short papillæ on the right side, probably connected with the anus. The two species which may be referred to this genus were detected in Devonshire by Montagu.

The *Scyllea.*—Branchiæ disposed on lateral membranaceous expansions, which serve the double purpose of supporting the branchiæ, and acting as fins, are seated dorsally on the fins; tentacula two; each side of the back has two expansions, and one on the tail, supporting on their dorsal surface scattered plumose branchiæ. The tentacula have each large funnel-shaped sheaths; the foot is very narrow, with a mesial groove, used in climbing up the stalks of sea weeds; the mouth is at the base of the tentacula, and surrounded with a semicircular lip; the tongue is tuberculated, with reflected points; the gullet is plaited longitudinally; the stomach is short and cylindrical, with a ring of hard longitudinal scales; the liver consists of six unequal globules, and the bile is poured into the cardiac extremity of the gullet. The *Scylla pelagica* has been long known, and appears to be very common in the equatorial seas, adhering to the stems of the *Fucus natans.*

The *Glaucus* has the branchiæ seated on the margin of the fins; four simple tentacula; on each side of the body are three or four membranaceous expansions, whose margins are fringed with the simple branchial filaments.

The *Tethys* has the body oblong, fleshy, and without feet; the mouth is destitute of corneous jaws, and consists of a cylindrical proboscis under the duplicativa of a lip. The branchiæ form a row on each side the back, consisting of fringed processes, alternately larger and smaller; and there are two at the left side of the neck. These resemble the aquatic pulmoniferous gasteropoda. The branchiæ appear like a feather, with a row of compound branches on each side decreasing from the base to the free extremity of a central stem that issues from the middle of the neck, behind the anterior tentacula. Near the plume, towards the right, is a single simple filament, like a tentaculum. The anterior tentacual occupy the usual position, are setaceous, and have the eyes placed at the base behind. The spiral shell is capable of containing the body, and the aperture can be closed by a spirally striated operculum attached to the foot. The internal structure is unknown. Branchiæ issuing laterally from between the cloak and foot.

The *Limpet* or *Patella.*—Shell simple, entire: mouth with tentacula; the animal being of the snail kind. There is a very singular species, (*P. anomala,*) the animal being a limax, different from all others, and formed of two tough spirally twisted lobes, fringed round with bluish crisp filaments, united to the lobes by a blue tendon; the ovaries two vascular foliaceous branchiæ, of an orange colour; the ovula are globular, whitish, while in the ovarium, purplish when first excluded, and orange when the young are fit for bursting into life.

The Sea-Hare, *Aplysia.*—Branchiæ with a corneous lid. The body is adapted for creeping; is covered with membranes reflected; it hath a shield-like membrane on the back, covering the lungs, a lateral pore on the right side, the anus on the extremity of the back, with four tentacula resembling ears.

The *A. depilans*, the type of the genus, is of frequent occurrence on the British shores, and grow from two to five inches in length, and to more than an inch in diameter: its body approaches to an oval figure, and is soft, punctuated, of a kind of gelatinous substance, and of a pale lead colour: from the larger extremity there arise four oblong and thick protuberances: these are the tentacula; two of them stand nearly erect, two are thrown backward. It is not uncommon about our shores, especially off Anglesia. It causes, by its poisonous juice, the hair to fall off the hands of those that touch it; and is so extremely fetid as to create sickness at the stomach.—The major, or greater sea-hare, grows to the length of eight inches. It inhabits the shores of Barbary, among rocks, and when touched, it discharges a black and red sanies, but not fetid or depilatory like the preceding.

The *Janthina.*—Foot with an adhering spongy body. In *Helix Janthina* the spongy body is capable of changing its dimensions, and enabling the animal to sink or rise in the water at pleasure. When irritated, it ejects a purple fluid from the cellular margin of the cloak above the gills, not unlike the Aplysia. It has a violet-coloured shell, is remarkable for the extreme thinness of its texture, which breaks with the least pressure, and seems therefore entirely calculated to keep the open sea, or at least to shun rocky shores. It inhabits the seas of Europe, especially the Mediteranean; those of Asia and Africa; and also the ocean. The living animal when touched, exudes a juice which stains the hands of a violet colour. A species has lately occurred at several places of the Irish coast. The shell is completely concealed in the animal, the opening is triangular, and there is an angular sinus at the right edge.

Dr. Hawkesworth, in his account of Cook's voyage, mistakes this shell for that which yielded the *purpura* of the ancients. But whoever looks into Pliny, can never have the least idea that the thin shell aforementioned could be the same with it. They had several shells which yielded the purple dye: but these were all rock-shells, and very different both in figure and hardness from the janthina; which is not calculated for the neighbourhood of rocks, as already mentioned.

The *Velutina.*—Foot simple. Anterior margin of the aperture of the shell canaliculated. This groove in the aperture of the shell is produced by the anterior margin of the cloak being extended over the opening into the gills, like a tube or syphon, to convey the water to and from the branchial cavity. The species are oviparous, with sexes in separate individuals. In some species the *convoluted* shell has a lengthened mouth parallel with its length. The whorls, which are small segments of large circles, are wrapped round the pillar, and rise little above each other: the shells of both kinds are much valued, as resembling papal crowns, mitres, &c. and embrace or enclose the preceding.

Murex.—The animal is of the snail-kind: the shell consists of one spiral valve, rough, with membranaceous furrows; and the aperture terminates in an entire canal, either straight or somewhat ascending. From a species was obtained the famous Tyrian dye so much valued by the ancients; but long superseded by the use of the cochineal. One of the shells producing the dye was the buccinum; but the finest, or Tyrian purple, was got from the murex. These shells are found in various parts of the Mediterranean. Immense heaps of them are to be seen about Tarentum to this day, evincing one place where this precious liquor was extracted. A Spanish philosopher mentions that, also on the coasts of Guayaquil and Guatimala, in Peru, the murex is found. The shell which contains it adheres to rocks washed by the sea, and is of the size of a large walnut. The liquor may be extracted two ways; some draw the animal when out of the shell; then kill it by pressure with a knife; separate the part where the liquor is collected, and throw away the other. When this operation on several snails, has afforded a certain quantity of fluid, the thread intended to be dyed is dipped in, and the process is finished. The colour, at first is the whiteness of milk, becomes afterwards green, and is not purple till the thread is dry. Others disapprove of this method, and draw the fish partly out of the shell, and, squeeze it till it yields a fluid for dyeing; and repeat this operation four times at different intervals, but always with less success. If they continue it, the fish dies. No colour at present known, (says Abbe Raynal,) can be compared to this, either as to lustre, liveliness, or duration; it succeeds better on cotton than wool, linen, or silk. This group includes the order Scutibranchia of Cuvier. They much resemble in general form, and structure and position of the branchiæ, the preceding. They differ, however, in many particulars. The heart has two auricles, and is perforated by the intestine. The sexes either are incorporated in the same individual, or the male organs are unknown. The body is protected by a shell, whose aperture is wide, and never closed by a lid.

The *Sea-Ear, (Haliotis.)* The animal is a kind of limax; the shell is ear-shaped, flat, with a lateral and nearly concealed spire; the inside of the finest pearl. The left margin in theHaliotis is pierced by a row of holes, and the animal has been observed always to close one towards the spire, whenever, as he grows larger, he opens another towards the head; thus preserving the number. In the Padola, these holes are nearly obliterated; but there is an internal groove and external ridge in the line of their direction. In the Stomatia, there are neither holes or ridges.

The *Terebratula.*—Valves unequal, the peduncle passing through an aperture in the largest valve; the arms are shorter than those of the Lingula, and are said to be forked. They are supported within by numerous arcuated plates.

M. Lamarck divides the recent kinds into two sections. 1. *Shell smooth, or destitute of longitudinal ribs.* The *T. cranium*, a native of the Zetland seas, may be quoted as an example. The peduncle is simple. 2. Shell ribbed longitudinally. The *T. aurita*, which inhabits Loch Broom, is a recently discovered British example. The larger valve is broadest in the middle, semicircular in front, and narrowing towards the apex, the sides being compressed inwards. The ribs from the beak towards the anterior margin are distinct, rounded, and about eight in number; those towards the sides are obsolete. The under valve is nearly orbicular, with the margin at the hinge truncated, or obtusely angular, the sides depressed, and forming small auricles, as in the Pecten, but not produced; the ribs obsoletely wrinkled across, and the margin waved by the ribs internally concave; the inner surface of both valves, especially the largest, is finally punctulated; the hinge is a projection on each side, the proximal margin of the perforation in the large valve entering corresponding depressions in the smaller; the margin of the perforation is completed by the application of the smaller valve. The peduncle is short, of numerous unequal-sized tubular threads, attached by a complicated tendino-muscular apparatus, chiefly to the larger valve. The spiral arms seem to have simple summits, and are destitute of testaceous plates.

The fossil species of this genus are numerous, and occur in the old and new floetz formations. They furnish obvious characters for the construction of many genera, some of which have been already established.

LECTURE XLI.

THE power of locomotion is denied to many species of testaceous animals. Some are immoveably cemented to rocks and stones, as oysters; a few are attached by a cartilaginous ligament, as the Anomiæ; while some others are fixed by a *byssus;* which consists of numerous filaments from a complicated apparatus in the breast. The *foot* is a little towards the mouth, usually tongue-shaped, capable of elongation, with a furrow on its posterior surface; and considered, where a byssus is present, as employed in opening and fixing the threads; but, when there is no byssus, it either acts as a sucker, enabling the animal to crawl along the surface of bodies, or as a paw, to dig holes in the sand or mud. The species cannot float in the water; they either crawl, or leap, by suddenly opening and shutting the valves. In securing a residence, some species *bore* into different substances by a rotatory motion of the shell. It was supposed that the dwelling was formed by a secretion affecting the solution of the surrounding substance; but the very different substances penetrated by the same species, as lime-stone, slate-clay, and wood, prove such a supposition to be erroneous.

The nervous system is little developed. The superior and inferior ganglia, surrounding the gullet, give rise to all the nervous filaments through the body. The digestive organs are scarcely less simple. The food is soft and swallowed entire, and either brought to the mouth by accident, or by eddies produced in the water, by opening and shutting the shells, or aided by the syphons.

By laying the animal upon its back, and opening the cloak, the abdomen occupies the middle longitudinally, and the branchia are ranged on each side; the mouth is at the exterior extremity, a simple aperture enters into the gullet, or stomach, surrounded by four flattened moveable tentacula, two united with the cloak in some, while in others they are free to the base; and in their structure they resemble the branchiæ. The stomach is full of cells, whose bottom is pierced with a biliary duct. A singular organ, the *crystalline process*, cylindrical, cartilaginous, and transparent, is, in some species, projecting into the stomach. The liver is large, surrounds the stomach, and pours out its contents by numerous openings. The branchiæ consist of two ribbands on each side, extending the length of the body, free on the sides and margin, striated transversely; and frequently of unequal size. The blood is brought to them by pulmonic veins, without the intervention of the heart. The aërated blood is transmitted to a systemic heart, consisting of one or two auricles, and a ventricle.

The reproductive organs of the Bivalvia, hitherto examined, consist of an ovarium, occupying the sides of the body, and penetrating the membranes of the cloak. They appear to have the organs of both sexes incorporated, and to propagate without intercourse. Many species are ovoviviparous; in which case the eggs, when ripe, pass into the gills, where they are hatched.

The *Scallops (Pectens,)* are in general inhabitants of the Indian seas; some frequent those of Africa and Australasia. The most remarkable is the great scallop, (the *ducal-mantle pecten.*) It has fourteen rays, very prominent and broad, and striated both above and below; rugged, and imbricated with scales; they grow to a large size, in beds by themselves; are dredged up, and barrelled for sale. They have a power of removing themselves from place to place by vast springs or leaps. They were used both by the Greeks and Latins as food; and, when dressed with pepper and cummin, were taken medicinally. The scallop was worn by pilgrims on their hat, or the cape of their coat, as a mark that they had crossed the sea in their way to the Holy Land, or some distant object of devotion. The name *pecten* seems to have been given to these animals, from the longitudinal striæ with which their surface is covered, which resemble the teeth of a comb. By the general character of this shell, it evidently includes cockles as well as scallops, which are the pectens without ears, and having less flat or elated shells. The ears, indeed, are the common marks of distinction between the pectens and the cockles, which last usually have none; yet there are shells allowed to be pectens or scallops, which have no ears; and others as universally allowed to be pectuncles or cockles which have ears. The pectines by some are esteemed as delicious food as the oyster. They differ very materially in a variety of circumstances. The pectens, as we have already observed, sail on the surface of the water; and besides, if they are attacked by a foe, they let down the membrane which nature has provided them for a sail, and drop to the bottom.

Even those shell-fish apparently the most sluggish, and destitute of any apparatus for motion, are furnished with instruments enabling them to perform all those movements for which they have any occasion. Thus, the scallop can both swim upon the surface of water and move upon land. When deserted by the tide, it opens its shell to the full extent, and, shutting it again with a sudden jerk, the reaction of the ground gives such an impulse to the whole, that it sometimes springs five or six inches from the ground; and by a continued repetition of this action, it gradually tumbles forward until it regains the water. Its method of sailing is still more curious. Having attained the surface of the water, by means unknown to us, it opens the shell, and puts one half above water, the other with the body of the animal in it remaining below. Great numbers of them are thus frequently seen sailing in company, with their shells sticking up above water, when the weather is fine, and the wind acting upon the membrane which nature has provided for each of them as a sail; but on the least alarm, or when attacked by a foe, they instantly shut their shells, and sink to the bottom.

The *Anomia* or *Bearded Cockles*,—are natives of the British seas, viz. 1. The *ephippium*, with the habit of an oyster; the one side convex, the other flat; perforated; adherent to other bodies, often to oyster-shells, by a strong tendinous ligature; colour of the inside perlaceous. Size, near two inches diameter. 2. The *squammula*, with shells resembling the scales of fish, very delicate, and silvery; much flatted, perforated, very small. Adheres to oysters, crabs, lobsters, and shell. The species are commonly called *beaked cockles*. No name has been given to the fish that inhabit it; for the recent shells are so rare, that scarcely one is found perfect. They are, perhaps, as well as that which has given its form to the *cornu ammonis*, inhabitants of the deepest parts of the ocean; consequently some extraordinary agitation of that great body of water can alone bring them to our knowledge. The fossile species of the *anomia* genus are uncommonly numerous in this island, in our chalk-pits and limestone quarries; and in Gloucestershire, they are as common on the ploughed lands, as pebbles in other places.

The *Nacre, (Pinna.)* The animal resembles a slug; the shell is gaping at one end, and the valves are without a hinge. It produces a delicate kind of byssus, which is woven into a cloth highly esteemed by the Italian ladies. The animal is very rich as food.

The *Arca*, (*Boat or Chest.*) The animal is a nethys, the shell is equivalve, the hinge has numerous sharp teeth which alternate between each other. Many species gape a little at the superior margin, to enable the animal to send out those tendinous threads by which it adheres to the rocks. The hinge is in a straight line, and composed of many small lamelliform teeth, without lateral ribs. The Noah's Ark being much like the keel of a ship are much valued.

Mytilus, the *Mussel.*—The animal is an ascidia; the shell bivalve; often affixed to some substance by a beard; the hinge without a tooth, marked by a longitudinal hollow line. Of these animals there are many species, some inhabiting the seas, others the rivers and ponds. Several are remarkable for the beauty of their internal shell, and for the pearls sometimes found in them.

The *Modiolus*, or great mussel, with a strong shell, blunted at the upper end; one side angulated near the middle; from thence dilating towards the rounded end. It dwells in the Mediterranean, Indian, European, and American seas; and its flesh, of a deep orange colour, is eatable. It is the greatest mussel known in Britain, from six to seven inches long; it lies at great depths, often seizes the baits of ground-lines, and is taken up with the hooks.

The *Anatinus*, or duck mussel, has a shell very brittle and semi-transparent; the length about five inches, breadth two. It is found in Europe in fresh waters. It is devoured by swans and ducks; crows also feed on these mussels, as well as on different other shell-fish; and, when the shell is too hard for their bills, they fly with it very high, drop the shell on a rock, and pick out the meat when the shell is fractured by the fall.

The *Margaritiferus*, or pearl-bearing mussel, has the shell compressed and flat, nearly orbicular, the base transverse, and imbricated with dentated coats. It dwells in the Indian ocean. This is the mother-of-pearl shell. On the inside it is exquisitely polished, of the whiteness and beauty of pearl itself. It has also the same lustre on the outside after the external laminæ have been taken off by aquafortis and the lapidary's mill.

The *Lithophagus*, or stone-eating mussel, has the shell cylindric, the extremities both ways rounded. It inhabits the Indian, European, and Mediterranean seas, penetrating and eating away marbles, corals, &c. The Indian shell is softer and nearly tough like leather, but the European is more brittle.

The *Chama gigas* is sometimes of such an astonishing bulk, as to weigh above five hundred and thirty pounds, and the inclosed animal is so large as to supply a dinner for a hundred and twenty people; and it can open and shut with such celerity and force as to snap off a man's leg?

The *Pinna*,—though blind, has very strong calcareous valves. The cuttle-fish is its deadly foe, rushing on like a lion as soon as the pinna opens the shell; and would devour it but for another animal, a species of crab, (the *Alpheus*,) protected in its shell, and grateful for such protection. Being very quick-sighted, it quits the shell of the pinna to seek food; while the shell is open, the cuttle-fish approaches, and would devour the pinna, if the crab did not instantly return, warn his host of the danger, and cause the shell to be closed. Hasselquist witnessed this circumstance; and it is stated by Aristotle and Pliny as well known to the ancients.

The *Pinna marina* produces pearls, of different colours, and the shells of some kinds often weigh twelve pounds, and furnish a reddish mother-of-pearl. The *pinna marinæ* differ less from muscles in the size of their shells, than in the size and qualities of a certain tuft of silk, which issues from the body of the animal, at the place where the shell opens; and, about four or five inches from the point in the large pinna, the threads attach them to the rocks, hold them in a fixed situation, secure them from the rolling of the waves, and assist in laying hold of slime. These threads are nearly as fine and beautiful as silk from the silk-worm, and become a silk proper for many purposes, and very beautiful stuffs, in the manufactures of Palermo. The delicacy of this singular thread is unrivalled, many pinnæ being required for one pair of stockings, which can be put in an ordinary snuff-box. In 1754, a pair of gloves and stockings of this material were presented to Pope Benedict XIV.; and the latter, though so extremely delicate in structure, secured the leg from both heat and cold. A robe of such materials is mentioned by Procopius, (lib. 3. c. 1.) as the present of a Roman Emperor to the Satrap of Armenia.

The *Venus.* The animal resembles a tethys; but its structure has not yet been perfectly examined. The shell has the frontal margin flattened with incumbent lips, with three diverging hinge teeth; the anterior opening large, allowing the water free access to the mouth and gills, and the feet free motion. The shells are much prized by conchologists; and in the characters of them, Linnæus indulged in remarks unbecoming the philosopher. There are many species; a most remarkable one is the *merenaria*, or commercial, with a strong, thick weighty shell, with a brown epidermis; pure white within; slightly striated transversely. Circumference above eleven inches.—These are called in North America *clams*; they differ from other species only in having a purple tinge within. Wampum, or Indian money, is made of them.

The *Gaper*, (*Mya.*) This is noted as the Pearl-fish to which the jewellers are so much indebted. The shell gapes at both ends; the hinge is furnished with a strong internal ligament, and on a thick erect tooth in one valve, not inserted into the opposite side. Anterior opening small, and not exposing the mouth or gills. In this tribe the mantle is closed in front; and even when the valves are open, neither mouth nor gills are visible. The anterior opening serves for a passage to the foot; and the posterior openings, in the form of two long tubes, united by a common membrane, serve for the entrance and exit of the water to the mouth and branchiæ, and the dorsal syphon serving for the ejection of the fæces. The cuticle of the shell covers also the exposed portion of the cloak, so that, when the animal is removed from the shell, it remains as a loose membrane on the margin of the valves. All prefer concealment, burrowing in sand, mud, or wood, with the head downwards, with the syphons rising to the surface.

Pearls, though esteemed among gems by our jewellers, and highly valued in all ages, arise merely from a disease in the animal that produces them, analogous to bezoars, and other stony concretions, in several other kinds of animals.

The fish in which pearls are usually produced, is commonly called the East Indian pearl-oyster. Besides this, many others produce pearls; as the common oyster, the mussel, and several others, whose pearls are often very good; but those of the Indian berberi, or pearl-oyster, are superior. The seed-pearls, called *ounce-pearls*, from their being sold by weight, are numerous and common: but, like diamonds, among the multitudes of small ones, smaller and larger are found. As they increase in size, they are proportionably less frequent, which is the cause of the increased price. Philip II. of Spain, had a pearl, perfect in shape and colour, of the size of a pigeon's egg. The finest, and truest shape of the pearl, is a perfect sphere; but pearls of a considerable size, when pear-shaped, as is frequent, are not less valued, as they serve for ear-rings and other ornaments. Their colour ought to be a pure white, clear and brilliant; perfectly free from any foulness, spot, or stain; with their surfaces naturally smooth and glossy; for they have a natural polish, which art is unable to improve.

Though these ornaments are met with in all seas, the most esteemed are those of Asia, and the eastern coast of Africa. In Madura, east of Malabar, are many pearl-fisheries. Tutucorin is the principal place on the fishery coast. When the Portuguese were in power, the taking of oysters between Ceylon and the continent, was very deservedly styled the *fishery*; though some preferred the pearls taken near Baharen in the Persian gulf, or at Hainan on the coast of China.

The season of the fishery was the beginning of May, and the duration about a fortnight. Of its commencement, the sovereign gave public notice; and, there repaired to the place an indefinite number of fishing vessels, with divers, who plunged, and brought up the oysters in little baskets, till the boats were sufficiently laden. They were then carried to shore, where they were buried, till, by the solar heat, the fish dried up, and the pearls were easily taken out. The people employed, at sea and on-shore, amounted to many thousands; and the pavilions and tents for their accommodation made a fine appearance. When the pearls were extracted, cleansed, and dried, they passed them through sieves, by which their sizes were distinguished. The smallest, called *seed-pearl*, they sold by weight, and the rest according to size, and beauty, from a few shillings to ten or twenty pounds, and sometimes more.

The wretched divers go repeatedly down, only resting ten minutes or a quarter of an hour between each dive, during the twelve hours. A cord is fastened under the arms, and a large stone likewise to the great toe, the other ends being held by persons in the boat. On reaching the bottom, the diver slips from the stone, which is then drawn up; and collects in a sack, with the mouth distended by a hoop, all the muscles or oysters he can; and, when nearly exhausted, pulls the rope, on which he is drawn up by his comrades in the boat. To defend himself, he has a sharp knife; for sharks at times attack him, and a large flat fish there common keeps the diver under itself, and drowns him. In Percival's Account of Ceylon, mention is made of divers continuing five minutes under; that they go down by fives, alternately relieving each other. The fish are thrown in fenced places to die; and cause an inconceivable stench; but the pearls are supposed to be better in consequence. However fine the specimens, (and their value increases in proportion to their size and colour,) they become yellow by exposure to the air, or to dampness.

In Eastern Tartary are a variety of rivers, celebrated for pearl-fishing; but the pearls, on account of their defects in shape and colour, are little valued by Europeans. Many rivulets in Livonia produce pearls, almost equal in size and clearness to the oriental ones. There are several fisheries in both east and west Africa; and a considerable one round some small islands, near Sofala; but the people, instead of exposing the oysters to the sun's warmth, to induce them to open, lay them upon embers, by which the pearls contract a dull redness, which, robbing them of their natural lustre, injures their value. In the sea of California are very rich pearl-fisheries. In Japan are found pearls of great price; also in the Red Sea, the Indian Ocean, and on the part of Arabia Felix named *Baharen*, adjoining to the Persian Gulf; likewise on the low coast about Gunibroom, east of the Persian Gulf; and many of the finest kind are met with on the coasts of Ceylon. They are plentiful in Baharen, between the coast of Arabia Felix and Ormus, whence they are transported by Aleppo to Leghorn, and circulated through Europe.

In the time of Pliny, pearls were the most valuable and esteemed of all precious stones; and Jesus Christ, in comparing the kingdom of heaven to a pearl, indicated that they were then held in high estimation. Servilia, the mother of Marcus Brutus, is stated to have presented one to Cæsar, worth 50,000*l.* sterling; and Cleopatra is said (but the story is not believed) to have dissolved one worth 250,000l. which she drank at a supper.

The mother-of-pearl manufactory is brought to the greatest perfection at Jerusalem. The most beautiful shell is the peninim, a kind of pinna; but it is too brittle to be employed in large articles; hence that kind named *dora* is usually employed; and great quantities are daily brought from the Red Sea to

Jerusalem, of which are made all the fine works, the crucifixes, wafer-boxes, and beads, sent to the Spanish dominions in the New World; and they produce a return incomparably greater than the staple of the greatest manufactory in the Old.

The *Pholas* derives its name from making and living in holes in earth, sand, wood, or stone ; by what means, however, are as yet not well known. They must have penetrated these substances when very small; because the entrance of their hole is always much less than the inner part; and, indeed, than the shell of the pholas. Hence some supposed that they were hatched in holes accidentally formed in stones, and that they naturally grew of such a shape as was necessary to fill the cavity. The holes in which they lodge are usually twice as deep, at least, as the shells are long; the figure is a truncated cone, terminated at the bottom by a rounded cavity, and their position oblique to the horizon. The openings betray the pholas, but are always very small in proportion to the size of the fish. There seems no progressive motion of any animal in nature, so slow as that of the pholas; it is immersed in the hole, and has only a small movement towards the centre of the earth, and this in proportion to the growth of the animal. Its work is very difficult; but it has much time to perform it in, as it only moves downward, sinking deeper in the stone as it increases in bulk. That part by which it performs this, is a fleshy substance, near the lower extremity of the shell, of a lozenge shape, and very large in proportion to the size of the animal; and, though of a soft substance, it is able, in so long a time, by constant work, to burrow into a hard stone. Their manner of performing this, may be seen by taking one out of the stone, and placing it upon some soft clay ; it will immediately go to work in bending and extending that part allotted to dig; and, in a few hours, will bury itself in the mud in as large a hole as it had taken many years to make in the stone. It finds little resistance in so soft a substance; and the necessity of hiding itself evidently makes it hasten the work.

The animal is lodged in the lower half of the hole in the stone, and the upper half is filled up by a pipe of a fleshy substance, conical, and truncated at the end; this they usually extend to the orifice of the hole, and place on a level with the surface of the stone, but seldom farther. The pipe, though it seems single, is in two pipes, or composed of two parts, separated by a membrane The use of this proboscis is the same with that of other shell-fish, to take sea-water into their bodies, and afterwards to throw it out. In the middle of their bodies they have a small green vessel, whose use has not yet been discovered. This, when plunged in spirit of wine, becomes of a purple colour; but its colour on linen will not become purple in the sun, as will that of the murex; and even if it would, its quantity is too small to make it worth preserving.

The pholas is remarkable for its luminous quality. This luminosity was noticed by Pliny, who observes, that it shines in the mouth of the person who eats it; and, if it touch his hands or clothes, it makes them luminous; and also, that the light depends upon its moisture. The light of this fish has furnished matter for various observations and experiments to Reaumur, and especially Beccaria, who took much pains with the subject of phosphoreal light. Reaumur observes, that, whereas other fishes give light when they tend to putrescence, this is more luminous in proportion to its being fresh; that, when dried, the light will revive if they be moistened either with fresh or salt water, but that brandy immediately extinguishes it. He endeavoured to make this light permanent, but none of his schemes succeeded.

Beccaria observed, that though this fish, ceased to shine when it became putrid, yet that in its most putrid state it would shine, and make the water, in which it was immersed, luminous when it was agitated. Galeatius and Montius found that wine and vinegar extinguished this light; that in common oil it continued some days, but in rectified spirit of wine or urine scarcely a minute. To observe how this light was affected by different degrees of heat, Reaumur's thermometer was used, and shewed, that water, rendered luminous by these fishes, increased in light til.

the heat arrived at 45°, but that it then became suddenly extinct, and could not be revived again.

In the experiments of Beccaria, a solution of sea-salt increased the light of the luminous water; a solution of nitre did not increase it quite so much. Ammonia diminished it a little, oil of tartar *per deliquium* nearly extinguished it, and the acids entirely. This water, poured upon fresh calcined gypsum, rock crystal, ceruse, or sugar, became more luminous. Its effects were tried upon various other substances, but without any thing very remarkable in them. Afterwards, using luminous milk, he found that sulphuric acid extinguished the light, but that of tartar increased it. He had the curiosity to try how differently coloured substances were affected by this kind of light; and having, for this purpose, dipped several ribbons, the white came out the brightest, next the yellow, then the green; and the other colours could hardly be perceived. Not any particular colour, however, but only light, was perceived. He then dipped boards painted with the different colours, and also glass tubes filled with substances of the different colours, in water rendered luminous by the fishes. In both cases, the red was hardly visible, the yellow was the brightest, and the violet the dullest. But on the boards, the blue was nearly equal to the yellow, and the green more languid; whereas in the glasses, the blue was inferior to the green. Of all the liquors to which he put the pholades, milk was rendered the most luminous. A single pholas made seven ounces of milk so luminous, that the faces of persons might be distinguished by it, and it looked as if it was transparent.

Air appeared necessary to this light; for, when Beccaria put the luminous milk into glass tubes, no agitation would make it shine unless bubbles of air were mixed with it. Also Monlius and Galeatius found, that, in an exhausted receiver, the pholas lost its light, but the water was sometimes made more luminous; which they ascribed to the rising of bubbles of air through it. Beccaria, as well as Reaumur, had many schemes to render the light of pholades permanent. For this purpose, he kneaded the juice into a kind of paste with flour, and found that it would give light when it was immersed in warm water; but it answered best to preserve the fish in honey. In any other method of preservation, the property of becoming luminous would not continue longer than six months, but in honey it had lasted above a-year; and then it would, when plunged in warm water, give as much light as ever it had done.

Teredo.—The shell of this fish is tapering, bending, and capable of penetrating wood. The species, *navalis*, or ship-worm, has a very slender, smooth, cylindrical shell, and inhabits the Indian seas, whence it has unfortunately been imported into Europe. It penetrates easily into the stoutest oak-planks, and produces certain destruction to ships, by the holes it makes in their sides; and, to avoid the effects of this insect, vessels require sheathing with copper. The head of this creature is well prepared by nature for the hard offices which it has to undergo, being coated with a strong armour, and furnished with a mouth like that of the leech; by which it pierces wood, (as that animal does the skin;) a little above, it has two horns, a kind of continuation of the shell; the neck is, by suitable muscles, as strongly provided for the creature's service as the head; the other parts of the body are only covered by a very thin and transparent skin, through which the motion of the intestines is plainly seen by the naked eye; (and, by the microscope, several other very remarkable particulars are visible there.) This creature is wonderfully minute when newly excluded from the egg, but it grows to the length of four or six inches.

When the bottom of a vessel, or any piece of wood constantly under water, is inhabited by these worms, it is full of small holes; but no damage is obvious till the outer parts are cut away; then their shelly habitations appear, having a large space for inclosing the animal, and surrounding it with water. There is evident care in these creatures never to injure each other's habitations; thus each shell is preserved entire; and, in such pieces of wood as have been found eaten into a sort of honeycomb, there never is seen a passage or communication between any two shells, though the woody matter between is often not thicker than a piece of writing-paper. They penetrate some kinds of wood more easily than others. They make their way quickly into fir and alder, and grow to the greatest size. In the oak they make small progress, and appear small and feeble, and their shells much discoloured. As each animal is lodged in a solitary cell, without access to its own species, it has been matter of surprise how they increase to so vast a multitude. On dissection, every individual appears to have the parts of both sexes, and is therefore supposed to propagate by itself.

The BOTTLE-WORM, *(Ascidia.)*—Animals of this genus have the faculty of squirting out the water they take in, and the expansion and contraction of their bodies occasion their assuming various forms.

The *Malacostraca podophthalma* include those animals, named crabs, lobsters, crayfish, prawns, pandals, and shrimps; all of which have the power of reproducing their claws when they are lost. Crabs and lobsters have been said to change their crust annually, but this statement is incorrect. Dr. Leach mentions having seen *Maja squinado* and the common lobster *(Astacus gammarus)* so overgrown with ostreæ, anomiæ, flustræ, spongiæ, and sertulariæ, as to be scarcely able to move the joints of their legs; and, as the oysters were of a year's growth, the anomiæ above them, and the coralline matters upon the anomiæ, no doubt the crust was at least two years old.

Men use these animals as food; and, without due thought, commit the horrid barbarity of *boiling them alive;* and, sometimes, aggravate this cruelty, by heating the water gradually, so as to produce the most hideous cries from the poor animals. Nothing but a scarcity of all other food, or an actual famine, can be pleaded in justification of such practices.

LECTURE XLII.

INSECTS.

We now proceed to another class of organized beings, which differ also from *Vegetables*, in being enabled, by peculiar and curious arrangements, to move from place to place, and who are provided with powers to enable them to exercise the locomotive functions with safety. According to Sir Richard Phillips, vegetables, whose roots are fixed in the soil, and which exist always on the same spot, have no occasion for senses or perceptions, for, having no power of motion, a choice, or will, which could not be exercised, would be a cruel prerogative; and they are, therefore, passive organizations, which adapt the elements to the food or sustenance of the superior ranks of organized beings, which are enabled to move from place to place.

The wonderful contrivance by which the sublime Creator has enabled creatures to sustain themselves while they move about, is the bag, or cavity of the stomach, in which centre the roots or absorbents in the animal system. The soil, under the name of food, is conveyed by the process of eating into the stomach, where the roots of the animal extract the nutritive parts, and the remainder is subsequently ejected.

But, says the same writer, as creatures capable of moving about, and required to select their own food, would soon be destroyed without powers of feeling, seeing, hearing, smelling, and tasting, so they are provided with a sensitive system, called medullary, or with a system of nerves, which receive in the brain, through appropriate organs, situated in the head near the brain, the perceptions of SIGHT, HEARING, SMELL, and TASTE, while an extension of the same system through the frame enables them to FEEL in every part.

Experience then enables them to discriminate between what is beneficial or hurtful, and age confers on each kind a degree of experimental knowledge, corresponding with the sphere of existence and relative condition of the creature, and various habits, which, from want of information, or ignorance of their principle of action, we agree to call by the name of Instinct.

The attention of naturalists in general has been confined to an examination of the forms of insects and the number of their parts. Their internal structure has been in a great measure overlooked, and little accurate information is known concerning many of their functions. The task, indeed, of examining the anatomy of insects, is one of peculiar difficulty. The organs, in many cases, are complicated in their structure, and limited in size, so that, in dissecting them, the point of a fine needle must frequently be employed, and the eye requires the assistance of high magnifiers. There are few, therefore, who have prosecuted this department of enquiry with success, and who have inspired others with confidence in the accuracy of their statements.

We will confine ourselves, in the *first place*, to a brief exposition of the anatomy and physiology of insects.

1. *The Organs of Protection and Motion.*—The skin of insects serves the double purpose of protection and support. Its structure appears more simple than in the higher classes, as it neither possesses a mucous or cellular web, or true skin. It mostly resembles the cuticle of the skin, or the laminæ of perfect skins here form one uniform plate. It exhibits remarkable varieties. In the house-fly, it is soft and pliable; in the weevils, it approaches the consistence of bone. In some species, it is elastic, in others brittle.

Its appendices consist of spines, hairs, and scales. The spines are mere projections distributed over certain parts of the feet, to aid the locomotive powers. Hairs are often distributed over the whole body; and, at times, so exceedingly fine, as to require a powerful magnifier to show their character. These spines and hairs, being elongations of the skin, are not easily rubbed off. It is otherwise with scales: some inserted into the skin at their proximal, and free at their distal extremity, are so feebly connected, as to fall off by touching them with the finger. These scales, in the butterfly, have a remote resemblance to feathers, and are pleasing objects for the microscope.

The MUSCLES of insects possess the same internal structure as those in the higher classes; nearly all simple, transparent, and whitish. All those concerned in locomotion have their origin and insertion in the skin; the different members appear connected by a more transparent, tough substance, than the skin in other places. The action of the muscles will be best understood by a description of the different parts of the body, and the motions which these perform.

1. The HEAD of insects contains the mouth and the external sensitive organs. It joins the trunk behind, and its motions are regulated by its mode of connexion. When united by a cylindric ligament, the motion is various, limited in the dorsal direction by the superior margin of the trunk. When the articulation is by contact of the solid surfaces, these three modifications present themselves: *first,* two or more rounded smooth tubercles, received into corresponding cavities in the trunk; the motion either backwards or forwards. *Second,* the head rounded posteriorly, and received into a socket in the thorax; thus allowing great liberty of motion. In some cases, projections of the trunk limit it in one direction. *Third,* the contact of two flat surfaces; the head is frequently contracted behind, and the trunk in front, to diminish the uniting surfaces; which joint admits only of very imperfect motion. The muscles of the head rise near the abdominal edge of the trunk, and, entering the occipital hole, become attached to its margin. Those which move the head upwards rise on the upper part of the trunk; and from the under side those which depress it. These last are the largest. Those from the lateral parts, give its lateral motions.

2. The TRUNK, as the organ to support the other members, is the most important part of the body. It is usually divided into the thorax and breast. The *thorax* is the second ring of the body, united on the fore part with the head, and behind with the third ring or breast. In many species, this part is minute, in others large. On its ventral aspect, are the fore legs, or first pair, between which is the *thoracic sternum,* often resembling a keel, terminating by a spinous process, which rests upon the pectoral sternum, as in the water beetle. It is the only fixed part of the body, giving origin to the muscles of the head, the fore legs, and frequently to the breast and abdomen.

The *breast* is often so incorporated with the thorax, as to appear like one organ; and, in others, seems a part of the abdomen. The back frequently exhibits a horny process, termed *scutellum,* analogous to the thorax, to which it is united behind. At this place the wings have their origin. On the ventral side, it supports the middle and hind legs. Between these, at the base, is the *pectoral sternum;* in some species, a cover for the first joint of the hind legs; in others, covers a portion of the abdomen. The breast contains the muscles for moving the middle and hind legs, the wings and abdomen; and, also, some very strong muscles, from its ventral to its dorsal surface, calculated to bring these nearer together. This motion is facilitated by the sutures which traverse its skin.

3. The ABDOMEN, in some species, is sessile, and intimately united with the breast; in others, it is divided by a stalk. It consists of rings, varying in number in different genera. These rings are joined in many species, by simple adhesion of the margin; in others, the posterior margin of the one includes the anterior margin of the other. The whole abdomen moves by muscles in the breast; and, where it is sessile, the motion is very limited. The rings are susceptible of a little motion, when they are included. The muscular fibres which change position are longitudinal; from the posterior margin of one joint to the anterior of the other, and draw the ring aside, or pull it within that immediately preceding it.

4. The MEMBERS of insects are wings and feet.

The *Wings* vary in number, structure, and appendices. In one class, termed Apterous, they are wanting; in another they are two, but the greater number have four. These wings are either membraneous, supported by corneous ribs, forming a net-work substance; or, where the wings are four, the upper pair are sometimes crustaceous, named *elytra,* and serve to cover the inferior ones. The ribs of the wings, in manner of distribution, the hairs which covered them, and the vacant spaces, are very regular in the individuals of the same species. The membraneous wings are folded up in various ways; in some longitudinally, in others transversely, and in others obliquely. Each arrangement prevails through extensive groups. In the Diptera, under or behind each wing, is a stalk terminating in a small knob, termed *halteres,* or *poizers,* the rudiments of the second pair of wings. Between each poizer and the base of the wing, are one or two spoon-like scales, termed winglets, (likewise been observed in a coleopterous insect, *Dyticus marginalis)* In some of the diptera they are absent. The muscles which move the wings rise in the breast, and execute their functions with great celerity. The elytra perform only elevation and depression, and merely protect the wings when at rest.

The *Legs* of true insects are six in number. The first pair rise under the thorax; the second and third pairs under the breast. They consist of the hip *(coxa)*, the thigh *(femur)*, the leg *(tibia)*, the toe *(tarsus)*, and the claw *(unguis)*.

The *hip* unites the limb with the body; it is usually short, nearly as broad as it is long; it is imbedded in the thorax, or breast, and its motion is limited by the mode of insertion. Sometimes its proximal extremity is globular, and received into a corresponding cavity of the body, giving very extensive motion. In other cases, the coxæ of the hind legs are consolidated with the breast.

The *thigh* is usually united with the coxa, so as only to admit of motion backwards and forwards. In some tribes, the coxal extremity of the femur has one or two eminences; in some cases spines, termed *trochanters*, and being hollow, furnish suitable insertions to the muscles for particular motions. When the thigh is slender and cylindrical, the motion of the legs is confined to walking; but, where leaping is required, or even swimming, the thigh is thick, to give room to the requisite muscles.

The *leg* (tibia,) is so articulated to the femur as to admit of motion only in that plane in which it moves. In those insects which swim, this joint is long and flattened; in those which burrow, it is strong and serrated on the margin.

The *toe* (tarsus,) consists of several joints, looser than the preceding, and admitting motion outwards, inwards, and in a lateral direction. Its strongest muscle, as in the other parts, is the flexor. By this part the feet can apply closely to any object. The joints vary in number, length, and size; and, in many species, have very singular appendices, in particular those denominated cushions and suckers, situated on the under surface of the joints.

The *claw* (unguis) is attached to the distal edge of the last joint of the tarsus. In a few species it is single, capable of being opposed to a projection, serving the purpose of a thumb. In others double, and either moving in the same plane, or acting in opposition. The muscles of the different parts are all included in the limb; but those of the coxæ originate in the trunk. The former originates those of the tibia; the latter those of the first joint of the tarsus, and this again the one which succeeds. These muscles are chiefly fixors, placed on the ventral; and extensors, on the dorsal surface of the limb.

From this enumeration of the organs calculated for motion, we may see that insects are qualified for executing different kinds of motion. Some, indeed, can only walk, others can walk and leap; some can only walk and fly, others can walk, fly, and leap; while many can walk, fly, and swim; and, in addition, a few of these can leap.

II. *The Organs of Sensation.*—The nervous system, in the class now under consideration, exhibits more uniformity of structure and disposition than any of their other great systems of organs.

The brain in the head, on the dorsal surface of the gullet, consists of two lobes, slightly varied, and frequently so united, as to appear as one, marked in the middle by a groove. These lobes furnish the optic nerves, and frequently send filaments to the mouth. Near the posterior edge arise two cords, which, after proceeding backwards, and sometimes embracing the gullet, form a ganglion, whence nervous filaments proceed. From this ganglion two cords form a second ganglion; and the process is repeated until the cords terminate at the anal extremity. The number of ganglia differ with the articulations of the body. The cords, in some species, exhibit only the appearance of one.

The organs of the senses are imperfectly developed; the eye alone is the most perfect; and then the organ of touch. The existence of the other senses, common to the vertebral animals, is rather inferred from the actions performed, than from the structure of the parts.

III. *Organs of Nutrition.*—This division includes the alimentary canal, with all appendices,—the vessels employed in circulation,—and those destined for aerating the blood.

1. ALIMENTARY CANAL.—It is necessary to describe the parts employed in obtaining and preparing food for the gullet. In many cases, the legs, particularly the first pair, execute the first movement of seizing the food, and conveying it to the mouth; in general, however, the parts of the mouth, unassisted, seize, cut, bruise, and prepare, the food for the gullet.

1. The *masticating* organs include these following parts, (designated by their Latin, for want of appropriate English terms), labrum, mandibulæ, maxillæ, and labium; which form the mouth, and are denominated *Instrumenta cibaria.*

The *labrum* is analogous to the upper lip of other animals. It is articulated to the fore part of the head *(frons, clypeus, chaperon* of the French), by either a simple suture or intervening plate, named *nasus.* The labrum, at its free edge, exhibits varied characters in the condition of its margin; and is the cover to the other parts of the mouth above.

The *mandibulæ* are two, and rise immediately below the labrum on each side. They exhibit remarkable differences, in size, shape, and armature; they move horizontally, and cut objects, by their edges crossing like the blades of scissars.

The *maxillæ* are also two, united to the cheeks immediately beneath the mandibulæ, between them and the labium. They are more complicated than the mandibulæ; on their inner margin they are usually covered with stiff hairs; and, externally, they support the *palpi*, articulated appendages of several joints; each maxilla being furnished with one, rarely with two. The palpi probably serve as organs of smell, and perhaps also of touch.

The *labium* is analogous to the under lip, and closes the under side of the mouth, resting on the maxillæ. Its free edge is variously marked, usually with a line in the middle, indicating its tendency to be double. Each side supports a palpus of two or three joints. Its base is connected laterally by ligament, with the base of the maxillæ, and behind with a fixed plate jointed to the head, and termed *mentum*, corresponding, in position, with the nasus of the labrum.

When all these parts have such a proportion as to be able to cut the substances of the insects' food, and convey them to the pharynx, they are in the most perfect condition. But, in the different classes, they exhibit remarkable modifications. Many species live chiefly or exclusively on fluids unsuitable to such masticating organs. In those between the gnawers and suckers, the labium is a soft fleshy plate, like the tongue of quadrupeds, (hence frequently termed *lingua,)* capable of licking, and of being rolled inwards, when at rest,—as in the Hymenoptera, represented by the bee. In the genuine suckers, the organs of the mouth present two important modifications. *First*, the labrum is nearly obliterated; the labium is produced, and either crustaceous (rostrum), or membranaceous (proboscis), with a groove upwards, for the four plates or hairs into which the two mandibulæ and maxillæ have been converted, as exhibited in the Hymiptera and Diptera. *Second*, the labrum and mandibles are nearly obliterated; the labium is short and fixed; the two maxillæ are produced, and so applied, as to form a sucker, capable of being rolled up spirally; and in the Lepidoptera, the butterfly, is usually termed the proboscis, or tongue. These different parts of the mouth, however modified in size and shape, may still be readily detected, by either their position or palpial appendages.

2. The orifice of the *gullet* is a simple aperture, for receiving the food by the agency of the maxillæ. The Hymenoptera have an organ on the base of the mouth, to which the term *lingua* ought to be restricted. On the dorsal margin of the opening is likewise a particular process, denominated *epiglossa.* The gullet itself is usually membraneous, either simple, or having an enlargement, denominated the first stomach. The walls of the true stomach have the appearance of muscular fibres; which, in some of the Orthoptera, cover the surface, forming a true gizzard, fortified with teeth, or scales pointing backwards. The intestines are variously convoluted, and frequently, near the anus, exhibit an enlargement denominated a rectum. In some, the canal has one or more side pouches, or cæcæ, near the stomach.

The hepatic vessels (there being no secreting organ resembling a liver,) originate in the fluid contents of the abdomen, and send their capillary extremities to the remotest parts. They vary much in number and size; the walls are dense and cellular, and the bile secreted is yellow, brown, or white. In some, they terminate separately, in others they unite into a common duct. The terminations vary, in different species, at the pyloric extremity of the stomach, the middle of the intestine, or at the rectum.

Neither absorbing nor circulating vessels have been detected, though anxiously sought. The nutritive portion appears absorbed by the walls of the intestines, and discharged into the cavity of the body, where are neither veins, arteries, nor heart. Towards the back, is an obvious longitudinal vessel, by some named the heart; but, more generally, the *Dorsal Vessel.* This is widest in the middle, and diminishes at each extremity. Its walls consist of two membranes, the internal muscular, and the external cellular; so crowded with tracheal vessels, as to appear entirely composed thereof. All the coats have nervous filaments. It is kept in its position by the tracheal tubes, and muscular fibres, disposed in triangles, increasing in breadth from the superior part of the body to its inferior extremity. The contents of this vessel are fluid, but of such consistence, that, when its coats are punctured, no liquid flows out. The colour is similar to the adipose matter collected near its surface, and differs with the species. Placed under a microscope, this humour consists of grains, or globules, containing other globules. It mixes readily with water, and, when dried, resembles gum. The humour of this vessel is subject to some motion from contractions. These are irregular as to time, and proceed from the one extremity to the other, by stages corresponding with the rings of the animal, and strongest in the abdomen. The nerves have no influence on these contractions, while the muscular fibres and tracheal filaments have. These contractions, in some species, are thirty in a minute; in others, one hundred and forty, denominated pulsations; hence the organ has been termed a heart. To that viscus, it has resemblance only in its irregular contractions. It neither receives, nor gives motion to, any circulating fluid; but imbibes and converts the fluid of the abdomen into fat, as a supply when much nourishment is suddenly required, as during the metamorphoses of youth, and the production of eggs in maturity. The peritoneal membrane appears destined for executing the same functions.

There being no heart, and no circulation of the nutritive fluid obtained from the food, this fluid is *aerated* by a very complicated apparatus.

On each side of the body is a small orifice, termed *stigmata,* differing in number according to the species, formed by a cartilaginous ring, and furnished with one or more valves. Each orifice is the extremity of a short tube, opening internally into a cavity on each side of the body. From these lateral cavities arise tubes, termed *tracheæ,* very numerous at the termination of the stigmata, which convey the air to every part of the body, their coats consisting of an external and internal cellular membrane, with a middle layer, of a cartilaginous string, spirally twisted, resembling the spiral tubes of plants. In what manner the vitiated air is expelled, has not yet been ascertained.

Hence it appears that the chyle is absorbed by the inner surface of the alimentary canal; it exudes from its external surface into the common cavity; the tracheæ aerate this mass; and, while the dorsal vessel and the peritoneal membrane prepare fat, the hepatic filaments separate from it bile, and probably urine.

Nearly all insects, except spiders and a few others of the apterous tribe, undergo a *Metamorphosis,* or change, at three different periods of existence. The lives of these minute creatures in their perfect state, are generally so limited that the parents seldom see their living offspring. They are therefore, neither provided with milk, nor are they, like birds, impelled to sit upon their eggs in order to bring their offspring to perfection. They are endowed with the astonishing faculty of being able to discover what substance is fitted to afford the food proper for its young; though such food is generally different from that which the parent itself could eat.

When the eggs are hatched, the young are termed grubs, maggots, caterpillars, (technically, *larvæ.*) In this state they are proverbially voracious, and their digestive organs are much greater than when mature. In the condition of larvæ, insects possess various members, legs, suckers, hairs, and even stigmata, which they do not possess in maturity. They are all destitute of wings. Some live constantly in water, instead of on land, their future residence,—swimming in youth, and flying in maturity. The food of larvæ is often solid, requiring powerful jaws to gnaw it; while that of the perfect insect is fluid, and sucked up. When the larva has attained a certain size, and acquired the requisite quantity of fat, either by the food procured by its own industry, as the caterpillars, or by that brought to its cell, as in the grub of the bee, it prepares to assume the forms of maturity, by passing through the third stage of existence, as a *pupa*. In this state, the parts suitable only to the larva either become obliterated, or are changed into organs fit for maturity.

All insects, which do not eat and are motionless, as pupæ, retire to situations remote from enemies, and of suitable temperature. In many cases, for lodging the pupa with greater safety, the larva forms an exterior covering. In some, composed of threads of the well known substance, silk. Sometimes merely one or two threads keep the pupa in a proper position; in others, the silk is either woven, or matted together, resembling paper. These external cases are termed cocoons. Their matter is prepared by two long tubes, which rise in the abdomen, enlarge as they approach the head, and terminate by a duct, under the labium. By pressing the orifice of this duct to different places, the larva draws out the tenacious threads.

Those larvæ which live in cells ready fabricated for their reception, as the wasp and bee, are not contented with these as a covering during the pupa state, but they line their sides and bottom, and cover their mouth with silk, thus making a complete cocoon. These, after the insect has been perfected, are left in the cell, and, when it contains another larva, a second lining is also prepared. Each lining at the bottom, in the case of the bee, covers the excrement, which the animal had produced in its larva state. Hence, the walls of bee-combs appear double or treble; nay, there have been counted twenty different linings in one cell.

The external covering of the pupa, in some cases, consists of pieces of earth or dried leaves, curiously joined, and cemented by an adhesive secretion. After the insect has remained in a pupa state for a certain period, differing much in the various tribes, it bursts forth from its confinement, in its state of maturity. In this perfect condition it is termed the *Imago.*

According to Linnæus, insects are divided into seven orders:

1. *Coleoptera.*—This division contains all those insects whose wings are guarded by a pair of strong, horny cases, under which the wings are folded when at rest. These cases are called *elytra.*

2. *Hemiptera,* or half-winged.—The upper part of the wing-sheaths in this tribe is of a leathery texture, and the lower part a sort of membrane. The sheaths of this order cross each other when closed, instead of meeting in a direct line, as in the *coleoptera.*

3. *Lepidoptera,* or scaly-winged.—It consists of butterflies and moths. The powder on the wings of these insects has been said to consist of small feathers; but more accurate observation shows that they are minute scales, of various shapes and sizes in the different species, and even in the different parts of the same insect. The prevailing shape, however, is that of a fan, and they are ranged one over the other, like the tiles of a house.

4. *Neuroptera,* or nerve-winged.—The insects of this class are remarkable for the strength of their wings, which resemble a net-work of fine wire. They are always four in number. The order is beautifully exemplified in the *libellulæ,* or dragon-flies.

5. *Hymenoptera.*—It consists of insects furnished with four membranaceous wings, and also with a sting, or something resembling one. The wasp and the bee are examples of this order.

6. *Diptera.*—It contains those insects that have two wings only. In this order ranks the common fly, the gnat, and many others.

7. *Aptera.*—It consists of such insects as are entirely destitute of wing; as spiders, centipedes, fleas, and many others.

From the multitudes of insects that swarm in almost every situation, the ancients adopted the absurd opinion that they were nourished, and brought into life, by the matter in which they are found: thus, they supposed that flesh bred maggots; and dirt, those loathsome insects that are seldom seen but in the retreats of poverty or sloth. The enlightened philosophy of the present day has discarded such an unfounded notion, and clearly shown that all animals derive their being from parents of a like nature as themselves. They adopted another error, confuted likewise by more attentive observation, which might partly be attributed to the want of the microscope: they affirmed that insects had no blood, because it is clear and watery, instead of red. But the circulation of the blood is very visible in spiders; and especially in the common bug, in which the vibrations and contractions of the arteries are to be plainly discerned.

COLEOPTERA.

The insects of this class have their integuments of a hard coriaceous consistence. The wings are four: the upper pair, *elytra*, of the same texture with the skin; convex above, concave below, and at rest, their mesial margins join by *a straight suture*. In some the elytra are inseparable at the suture; in others, the elytra, at its base, are in contact, or lap over; while at the extremity they recede from each other. The inferior pair of wings are membranaceous, strengthened by anastomosing ribs; and at rest, folded obliquely and transversely, concealed under the elytra. When the insect is about to fly, the elytra are raised, and remain fixed while the under-wings unfold and execute their motions. In some species, the under-wings being imperfectly developed, or nearly obliterated, flying is impracticable: in such cases the elytra are cemented at the suture. The abdomen consists of six or seven rings covered by the elytra, each with sigmata, one on each side. The antennæ exhibit great variety in situation, length, form, and number of the joints. The eyes are two compound; each divided by the continuity of the marginal band of the head. There are no ocelli. The instrumenta cibaria are formed for cutting and masticating solid substances. The food, however, consumed by them, differs according to the species, in kind and consistence; so that all the parts of the digestive system exhibit extensive modifications. They are all oviparous. The larva is lengthened, frequently destitute of antennæ and eyes, of twelve or thirteen rings, with a scaly head, and the parts of the mouth similar to the perfect insect. It has usually six feet. After continuing months, or even years, in the larva state, it changes into a pupa obtecta, through the skin of which the different members may be distinctly perceived. The coleoptera, in their perfect state, require a supply of food, and live longer than other insects.

THE SCARÆBUS, OR BEETLE TRIBE.

All animals of the beetle kind, as in shell-fish, have their bones placed externally, and their muscles within. These muscles are formed much like those of quadrupeds; and with such surprising strength, that, bulk for bulk, they are a thousand times stronger than those of a man. Their strength is of use in digging the animal's subterraneous abode, whither it most frequently returns, even after it becomes a winged insect.

Besides the difference from the shape and colour, the size also makes a considerable one; in some being that of the head of a pin; and in others, as the elephant beetle, that of a pear. But the greatest difference is, some are produced in a month, and in a single season go through all the stages of their existence; while others have near four years to their production, and live as winged insects a year more.

The antennæ of the beetles are of a clavated figure, and fessile longitudinally; and their legs are frequently dentated. All the species concur in one common formation of having cases to their wings, which are the more necessary to those insects, as they often live under the surface of the earth, in holes dug out by their own industry. The cases prevent the various injuries their real wings might sustain by rubbing or crushing against the sides of their abode. And, though they do not assist flight, yet keep the internal wings clean and even, and produce a loud buzzing noise when the animal rises in the air.

The Pill Chafer is one of the most remarkable of the Beetle tribe. It appears from April, to September. It constructs a proper nidus for its eggs, by forming round pellets of dung, in the middle of each of which it deposits an egg. These, in September, the insects convey to the depth of about three feet into the ground; where they remain till the approach of spring, when the grubs burst their shell, and find their way to the surface of the earth.

This insect is of a dusky black colour, sometimes with a greenish hue above, and underneath of a very brilliant blue or green. The wing-cases are marked with several longitudinal streaks, and the thorax is round, margined, and hav a slight groove in the middle.

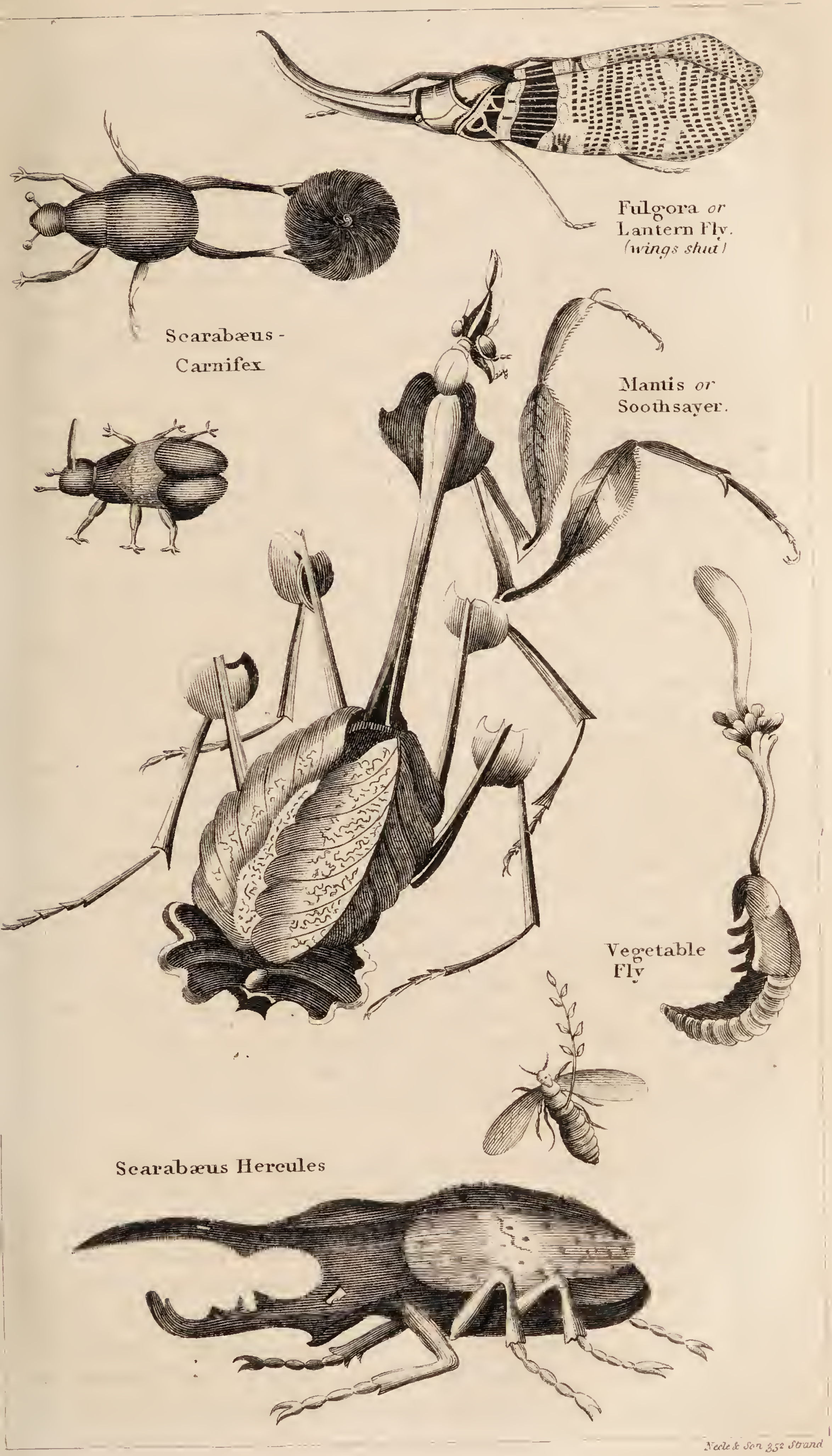
Dr. Brichell was supping one evening in North Carolina, when two Pill Chafers having been placed under the candlesticks, which, on a few blows being struck on the table, began to move about without any apparent agency; and, on taking up one of the candlesticks, it was ascertained that it was only a Chafer that moved it.

Dermestes.—The antennæ are clavated, with three of the joints thicker than the others, the breast convex; and the head inflected below the breast.—The *lardarius* is oblong, of a dim black, easily distinguishable by a light brown stripe, occupying transversely almost the anterior half of the elytra; caused by small grey hairs situated on that part. The stripe is irregular at its edges, and intersected by three transversal black spots on each elytra, the middlemost somewhat lower, giving it a serpentine form. Its larva, oblong, hairy, and in segments alternately dark and light coloured; found in old bacon; gnaws and destroys preparations of animals preserved in collections; and feeds even upon the insects.—The *domesticus* varies in size and colour, some being dark brown, others much lighter. It is oblong, almost cylindrical; the elytra striated; the thorax thick and rather gibbous. This little animal, when touched, draws its head under its thorax, and its feet beneath its abdomen, remaining motionless, as if dead. This is the insect which makes in wooden furniture those little round holes that reduce it to powder.—The *violaceus* is a beautiful little insect; its elytra are a deep violet blue; the thorax is covered with greenish hairs; the legs are black. The whole animal being of a glittering brilliancy renders it a pleasing object. The larva, as well as the perfect insect, inhabits the bodies of dead animals.—The *fumatus* is of a light brown colour, except the eyes, which are black. It is, however, sometimes more or less deep. The thorax is margined, and the insect has the whole carriage of a scarabæus; but its antennæ have the character of those of the dermestæ. This little creature is found in dung. It also frequently finds its way into houses.—The *ferrugineus* is the largest of the genus; its colour is a rusty iron, having many oblong, velvety, black spots upon the elytra, which give the insect a gloomy yet elegant appearance. The antennæ differ from the preceding species; the three last articulations being considerably longer, thicker, and not perfoliated. This insect is called the Leather-chafer, from the injury it occasions, in its larva state, to skins, furs, and other animal substances of a dry kind, upon which it preys with persevering destruction. To the collectors of stuffed birds, dried plants, &c. it is a terrible enemy, and can scarcely be destroyed but by arsenic.

Silpha, Carrion-Beetle.—The antennæ are clavated, the clava perfoliated, the elytra marginated, the head prominent, and the thorax marginated.—1. The *vespillo.* The margin of the thorax broad; the shells abbreviated, black, with two yellow belts; the thighs of the hind legs large, with a spine near their origin; length near one inch.—2. The *lipustulata,* is black; the antennæ are long and small, with two red spots on the middle of each shell. The length is one-third of an inch.—3. The *pustulata,* is black and oblong; there are four brown spots on the shells; the length is one fifth of an inch. It lives on trees.—4. The *quadripunctata.* The head, antennæ, and legs black; margin of the thorax and shells, pale yellow, with four black spots. The length half an inch. It is found in Caen Wood, near Hampstead.—5. The *sabulosa,* is black; the antennæ short and globular; five striæ on each shell; the shells and wings are short. There are five joints on the two first feet, four on the others. It lives in sand.—6. The *aquatica,* is brown, with a green bronze tinge. There are four ribs on the thorax. On each shell there are 10 striæ. The length is one-fifth of an inch.—7. The *pulicaria,* is black and oblong; the shells are abbreviated; the abdomen is rounded at the extremity; the thorax and shells are scarce marginated; the length is one line. It is found frequently running on flowers.

M. Gleditsch, a well-known writer on natural history, has illustrated the economy of the Vespillo, or Burying Sylph.

He had frequently observed, that moles which had been left upon the ground after they had been killed, very unaccountably disappeared. He therefore resolved, if possible, to ascertain the cause of this singular occurrence. He accordingly placed a dead mole on the moist, soft earth of his garden, and in two days he found it sunk four



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fingers' deep into the earth: it was in the same position, and its grave corresponded with the length and breadth of its body. The following day, the grave was half filled up; and he cautiously drew out the mole, and found under it, little holes, in which were four beetles of the burying Sylph species. At this time perceiving nothing but these beetles, he replaced them, and they quickly disappeared among the earth. He also replaced the mole, and having spread a little soft earth over it, left it. About eighteen days afterwards, he again took up the same carcass, which he found in the highest state of corruption, and swarming with small whitish worms, apparently the family of the beetles. He then took a glass vessel, and half filling it with moist earth, he put the four beetles with their young ones into the vessel, and they immediately concealed themselves. This glass, covered with a cloth, was placed on the open ground, and in the course of fifty days, the four beetles interred the bodies of *four* frogs, *three* small birds, *two* grasshoppers, and *one* mole, besides the entrails of a fish, and two small pieces of the lungs of an ox!

The account of the manner in which they performed this operation, is thus described by Mr. Bingley.

"A linnet that had been dead six hours was placed in the middle of the cucurbit; in a few moments the beetles quitted their holes, and traversed the body. After a few hours, one pair of the beetles only was seen about the bird: the largest of these was suspected to be the female. They began their work by hollowing out the earth from under the bird. They arranged a cavity the size of the bird, by pushing all around the body the earth which they removed. To succeed in these efforts, they leaned themselves strongly upon their collars, and, bending down their heads, forced out the earth around the bird like a kind of rampart. The work being finished, and the bird having fallen into the hollow, they covered it, and thus closed the grave."

"It appeared as if the bird moved alternately its head, its tail, its wings, or feet. Every time that any of these movements were observed, the efforts that the beetles made to draw the body into the grave, which was now nearly completed, might be remarked; in effecting this, they jointly drew it by its feathers below. This operation lasted full two hours, when the smallest or male beetle, drove away the female from the grave, and would not allow her to return, forcing her to enter the hole as often as she attempted to come out of it.

"This beetle continued the work alone for at least five hours; and it was truly astonishing to observe the great quantity of earth which he removed in that time: but the surprise of Mr. B. was much augmented, when he saw the little animal, stiffening its collar, and exerting all its strength, lift up the bird, make it change its place, turn, and, in some measure, arrange it in the grave that it had prepared; which was so spacious, and so far cleared, that he could perceive, exactly under the bird, all the movements and all the actions of the beetle. From time to time, the beetle, coming out of its hole, mounted upon the bird, and appeared to tread it down; then, returning to the charge, it drew the bird more and more into the earth, till it was sunk to a considerable depth. The beetle, in consequence of this uninterrupted labour, appeared to be tired: leaning its head upon the earth, it continued in that position nearly an hour, without motion; and it then retired completely underground. Early in the morning the body was drawn entirely underground, to the depth of two fingers' breadth, in the same position that it had when laid on the earth: so that this little corpse seemed as if it were laid out on a bier, with a small mount or rampart all round, for the purpose of covering it. In the evening the bird was sunk about half a finger's breadth deeper in the earth; and the operation was continued for nearly two days more, when the work obtained its final completion. A single beetle was put into the glass cucurbit, with the body of a mole, and covered, as before, with a fine linen cloth. About seven o'clock in the morning, the beetle had drawn the head of the mole below; and, in pushing the earth backward, had formed a tolerably high rampart around it. The interment was completed in this instance, by four o'clock in the afternoon, a space of time so short, that one could scarcely have imagined the operation possible, by so small a creature, without any assistance, and considering that the body of the mole must have exceeded the insect in bulk and weight at least thirty times."

Mrs. Barbauld thus characterizes this numerous and interesting order:

See the proud giant of the beetle race;
What shining arms his polished limbs enchase!
Like some stern warrior formidably bright,
His steely sides reflect a gleamy light:
On his large forehead spreading horns he wears,
And high in air the branching antlers bears:
O'er many an inch extends his wide domain,
And his rich treasury swells with hoarded grain.

LECTURE XLIII.

INSECTS, *(continued)*.

> We wonder at a thousand insect forms,
> These hatched, and those resuscitated worms,
> New life ordained, and brighter scenes to share,
> Once prone on earth, now buoyant in the air.—COWPER.

CICINDELA, *(the Sparkler.)*—See VOL. III.

This is a very beautiful tribe of insects; they are found in dry sandy places, and prey with the most ravenous ferocity upon all weaker insects which come in their way.

The *campestris*, or field-sparkler, is one of the most beautiful of the genus. The upper part of its body is of a fine green colour, rough, and rather blueish. The underside, as also the legs and antennæ, are of a shot colour, gold and red, copperish. The eyes are very prominent, and give the head a broad appearance. The thorax is angular, and narrower than the head, (the character of the Cicindela.) It is rough, and of a green colour, tinged with gold, as well as the head. The elytra are delicately and irregularly dotted. Each has six white spots, on the top of the elytrum, at the outward angle; three along the outward edge, the middlemost forming a lunula; a fifth, on the middle of the elytra, broader and roundish, opposite the lunula; and a sixth at the extremity of the elytra. Sometimes a black spot is seen on the middle of each elytrum, opposite the second white spot. The upper lip is white, and the upper side of the jaws, which are prominent and sharp. Its larva, which resembles a long, soft, whitish worm, armed with six legs, and a brown scaly head. It makes a perpendicular round hole in the ground, and keeps its head at the entrance, to catch the insects that fall; a spot of ground is sometimes entirely perforated in this manner. These insects are very beautiful, and merit the attention of the curious in microscopic observations; some are minute, though not inferior in splendour. For experiments and observations, dead subjects ought always to suffice, and, if living ones are used, cruelties should be carefully avoided. The larvæ live underground; and are, as well as the perfect insects, tigers in their nature.

GYRINUS, (*Water-Flea.*)

Some have supposed that this animal had four eyes; Barbut, however, says that the eyes only appear on the upper and under parts of the head, but that they are not four.

The natator, or common water-flea, is of a bright black colour; the feet are yellow, flat, and large; the insect is one-third of an inch long. It runs with great celerity in circles on the surface of waters, and is very difficult to catch, plunging down instantaneously when attempted to be taken. There are eight other species, which inhabit different parts of the globe, in lakes and still waters, from April to August; when it creeps to the tops of water-plants, where it weaves about itself a web like paper, in which it becomes a pupa. They live in society, and often in their brisk motions strike against each other. In the evenings they resort to still places, under bridges, or roots of trees at the edge of the water. When one dives, it carries with it a bubble of air, resembling a drop of mercury. The female deposits her eggs in rows on the leaves of water-grasses, which are hatched in three weeks. The larva at first is transparent; but afterwards is dark coloured, with a light fascia.

CURCULIO, (*Weevil Tribe.*)

The species of this genus are very numerous, and some of them are very large and beautiful.

The body is ovate, convex, narrower before, thorax round, or conic-cylindric, narrower than the base of the elytra; scutellum extremely minute; abdomen ovate, conic, suborate, or globose; lip minute; four filiform palpi; hinder feet not formed for leaping; antennæ clavated, on a horny prominent rostrum. The *C. palmarum* is black; thorax flat above; the elytra abbreviated and striated. Some of the largest species inhabit India, and are often brought in collections from China. They live on the palm-trees; and their larvæ are regarded as a delicacy; they are fried with butter and salt, and, when eaten, are said to partake of all the spices of the East.

The larvæ resemble oblong soft worms, and are provided anteriorly with six scaly legs, and scaly head. But the places where they dwell, and their transformations, afford some singularities. Some species dreaded for their mischief in granaries, find means to introduce themselves, while yet small, into grains of corn, and there abide. They are with difficulty discovered, as they lie concealed within the grain, where they grow at leisure, enlarging their dwelling-place, at the expence of the interior meal of the grain, on which they feed. Corn lofts are often laid waste by these insects, whose numbers sometimes devour and destroy all the grain.* When the insect, after having eaten up the meal, is come to its full size, it remains within the grain, hidden under the empty husk, which subsists alone; and there transformed, it becomes a chrysalis, and leaves it a perfect insect, making its way through the husk of the grain. It is difficult to discover with the naked eye the grains thus attacked by these insects, as they outwardly appear large and full; but the condition to which the curculio has reduced them, renders them much lighter; and, if corn infested by these insects be thrown into water, all the spoiled grains will swim, and the others sink to the bottom. Other larvæ of curculiones are not fond of corn, but fix similarly on several other seeds. Beans, pease, and lentils, preserved dry, are liable to be eaten by these little animals, which prey on the inward part of the grain, where they take up their habitation, until they have completed their transformation, and then break through the outward husk: this is discoverable by casting the grain into water, when those which swim are generally perforated by the curculiones. Other species lodge in the inside of plants. The heads of artichokes and thistles are thus often bored through and eaten away by the larvæ of large curculiones. Another species smaller, but singular, pierces and inwardly consumes the leaves of elms. Frequently most of all the leaves of an elm appear yellow, and as if towards one edge, while the remainder of the leaf is green. Upon inspecting those leaves, the dead part forms a kind of bag or small bladder. The two laminæ or outward pellicles of the leaf, as well above as below, are entire, but distant and separated; whilst the parenchyma between them has been consumed by several small larvæ of the curculio, that have made themselves a dwelling, in which they may be found. After their transformation, they come forth by piercing a kind of bladder, and give being to a curculio that is brown, small, and difficult to catch, because of the nimbleness with which it leaps. The property of leaping, allotted to this single species, depends on the shape and length of its hinder legs.

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* A gentleman of Paris, about the month of June, when his granaries and barns, that had been much infested by Weevils, were all empty, caused a number of the hills of the large ants to be collected in bags, and placed in different parts about them. The ants immediately attacked the weevils that were on the walls and other parts, and destroyed them so completely, that in a very short time not a single weevil was to be seen, and since that period, they never appeared on his premises.—BINGLEY.

The *Curculio imperialis*, or Diamond Beetle, is a native of Brazil; the ground colour of the wing-sheaths is coal-black, but they are beset with many rows of sparkling spots, of a gold green, which, when magnified, display the varying lustre of the most brilliant gems. This appearance is produced by innumerable minute scales, so polished and united, as to reflect the prismatic colours in this lively manner:

> ———— By myriads forth at once,
> Swarming they pour; of all the varied hues
> Their beauty-beaming parent can disclose.

The *Curculio regalis* is found in New Holland, and nearly equals the preceding in beauty; the wing-shells being decorated with large, shining, golden spots, arising likewise from a vast number of scales of that colour.

The *Curculio argentatus*, a brilliant species of the same genus, is a native of our own island, and is found in fields and gardens during summer.

THE CERAMBYX, OR CAPRICORN.

This genus is very extensive, and contains many insects of the most extraordinary appearance, and exceeding, in size, any in the order Coleoptera, except the Scarabæus, or Beetle Tribe.

The antennæ are setaceous; thorax spinous or gibbous; elytra linear. *C. cervicorius*, the thorax has three dents on each side; the mandibles projecting, with a spine on the outside. Their larvæ live in wood, which they perforate and consume, and are the favourite food of wood-peckers. The *Cerambyx longimanus* is nearly three inches long; the wing-shells are covered with a very fine down, and are elegantly variegated with red, black, and yellow stripes; the fore-legs are very long, and barred with red.

The *Cerambyx damicornis* is a native of many parts of America and the West Indies, where its larva is considered one of their greatest delicacies. They are called Macaccos: and it is said that the entire employment of some negroes is to scoop these maggots out of the bodies of trees, in which they live, and feed upon the inner substance.

The *Goat-Chafer, or Musk Beetle,* is one of this genus, and takes its name from its powerful scent, resembling that of musk, ambergris, and roses.

THE ELATER, OR SKIPPER TRIBE.

Many coleopterous insects with difficulty restore themselves when laid on the back; the apparatus of the Elater for that purpose, is singular and curious. An elastic spring or spine projects from the hinder extremity of the breast, and there is a groove in the anterior part of the abdomen. When laid on its back, the insect raises and sustains itself on the anterior part of the head, and the extremity of the body, and the spine is thereby removed from the groove wherein it naturally lodges; then, by a sudden bend of the body, the spine is forcibly struck across a small ridge into the cavity, and causes so forcible a re-action of the parts against the object whereon it was laid, that the body rebounds to a great distance. The antennæ lodge in a cavity scooped out of the under side of the head and thorax, probably to preserve them when the insect falls after its singular leap.

The *Elater* has the mandibles notched or bifid at their extremities; tarsi with all their joints entire; antennæ filiform, serrated; palpi four, securiform; colour black; thorax, except the hinder margin and elytra, red, finely punctated, pubescent; elytra with punctured striæ. When laid on its back, the animal leaps by a spine in its breast, springing from a cavity in the under side of the abdomen.

The size of the *Elater* varies. When the insect is young and newly metamorphosed, its elytra are of a beautiful deep red; but in a few days they change to a much darker hue, and are nearly of a chesnut colour. In the state of larvæ, it inhabits the trunks of decayed trees, and is there transformed. With the aid of its wings it issues from its prison, flutters upon flowers, wanders over the fields, and conceals itself in thickets or under the bark of trees.

The most remarkable of this genus is the *Elater Noctilucus,* called, in South America, *Cocujas.* In the savannas of most of the warmer parts of America, and about the woods of several of the West India islands, these insects are to be seen in great numbers.

Some shoot, like living stars, athwart the sight
And scatter from their wings a vivid light,
To guide the Indian to his tawny loves,
As thro' the wood with cautious steps he moves.

They are very luminous in the dark, the light proceeding chiefly from two glandular spots behind the eyes, and one under each wing. They have the property of interrupting this light at pleasure, when these glandular spots become perfectly opake. The same luminous appearance issues indiscriminately from every part of their interior, when the wings of the abdomen are divided. It diffuses such a brilliant phosphoric splendour, that a person may easily read the smallest print by its light: and, if eight or ten of the insects are put into a phial, they will give a light equal to that of a common candle. According to Oviedo, the Indians travel in the night with them fixed to their feet and hands; and they spin, weave, paint, dance, &c. by their light. Mr. Bingley says, the Indians value them from their hunting and devouring the musquitoes in their habitations, which would become otherwise excessively troublesome. They catch them in the night, by holding up a torch on some eminence, to the light of which the insects soon come, when they are beaten down with the branches of trees; or sometimes one of them is held up in the fingers and moved about, which will attract to the place such as are near, when they are either knocked down or seized with the hand. The Wire-worm, so destructive to corn, is supposed to be the larva of the *Elater obscurus.*

DYTISCUS *(the Diver)* TRIBE.

From the indefatigable research of modern entomologists, one hundred and forty-seven species of this genus have been ascertained.

The Margined Water-Beetle.—The larvæ are of a greenish variegated brown; they are very active, and so voracious, that they devour and feed upon other water-insects, and often tear and destroy each other. The perfect insect is little inferior to its larvæ in voraciousness, but it can only exercise its cruelty on the larvæ; the perfect insects, like himself, being sheltered by a kind of scaly cuirass. This creature should be touched cautiously; for, besides its power of giving a severe gripe with its jaws, it has, under the thorax, a long sharp spine, which it will drive into the fingers by its effort to move backwards. The eggs are rather large, and inclosed in a strong and thick silky duskish cod, round, and terminated by a long slender tail. These cods are often found in the water, and from them come the eggs and larvæ. Their strength probably serves the insect to defend their eggs from the voraciousness of several other aquatic creatures, and even from that of their fellows, who would not spare them. These insects are perfectly amphibious. The body is black; the edges of the thorax, and the outer margins of the wing-cases, are yellow; and the wing-cases of the females have numerous longitudinal grooves.

Many species of the perfect insect are common in stagnant waters, which they quit in the evenings to fly about. They swim with incredible agility, making use of their hinder legs after the fashion of oars. The elytra of the females are in general furrowed, and those of the male plain. When they first arrive at their perfect state, their elytra are almost transparent, and in many of a beautiful dun colour, mingled with greenish brown shades. The method of catching them is with a hand-net or sieve; for they are so nimble, and justly exercise their defensive weapons so often, and with such painful success to those who endeavour to catch them, that the wanton pursuer is compelled to give up his cruel torture.

CARABUS, OR GROUND BEETLE TRIBE.

The Bombardier, or Exploding Beetle.—This insect conceals itself among stones, and, when touched, makes a noise similar to the discharge of a miniature-musket, during which a blue smoke proceeds from its extremity. Rolander says, it can give twenty discharges successively. A bladder, near its posterior extremity, is the arsenal that contains its store. The head, antennæ, thorax, and feet, of this insect, are of a brownish red colour. The eyes are black, and the abdomen and wing-cases blue, nearly black; the latter are marked with broad but shallow striæ.

LYTTA TRIBE.

Lytta, or Spanish Fly.—This beautiful insect is found in Spain, Italy, France, and Germany. The largest come from Italy, but the Spanish are preferred.—In order to collect these insects, a cloth is extended round the foot of the tree, and they are shaken upon it. They are then taken up, tied in a bag, and killed with the vapours of hot vinegar. After this they are dried in the sun, and placed in boxes for use.

Nature has apparelled most of them splendidly. Green, azure, and gold, render them dazzling to the eyes. They are most common in the southern parts of the continent. The antennæ are jointed, the last joint being oval; the elytra are soft and flexible; and the head is inflected, and gibbous. These insects are divided into two families; one without wings, with the elytra shorter than the abdomen; the other winged, with elytra shorter than the body, and wholly covering the wings.

The *proscarabœus* is of a black colour, without brightness, though intermixed with purple towards the under part of the body. Its large head is dotted; as is the thorax, which is narrower, round, and without a margin. The elytra are as soft as leather, shagreened, and cover but part of the abdomen; they are cut off obliquely from the inner to the outer part, being shorter towards the suture, longer on the sides, and no wings under. The abdomen is large; and that of the female far exceeds the elytra. This insect's abode is on the side of wet roads, and in woods. Its food is insects, violet leaves, and delicate herbs, and from its body oozes a fat unctuous matter, of an agreeable smell.

The *Cantharis vesicatorius* (Spanish fly of the shops), or blistering meloe, is nine or ten lines in length, of a shining green colour, mixed with azure. They multiply greatly, and are sometimes seen flying in swarms. A nauseous smell, like that of mice, bespeaks their approach; which frequently leads to their discovery, when they are pursued. When dried, they are so light, that fifty scarcely weigh one dram. They prey upon the leaves of trees and shrubs, and prefer those of the ash-tree. The odorous particles exhaled by these insects being extremely corrosive, great caution should be used in picking them; persons have been seized with violent heat of urine, and voiding of blood, through having gathered a quantity, during the sun's heat, with their hands bare; or for having slept under the trees where swarms had settled.* The females deposit their eggs in the ground, whence proceed larvæ, which pass through the state of chrysalids, to attain that of meloes.

Oil infused by the first species, is said to be excellent for wounds, and the scorpion's sting; and it enters into the composition of salve for sores. The insects, bruised and mixed with oil or honey, are commended as a remedy in the rabies canina. The second species is used in blistering plaster. The largest and most esteemed come from Italy; they are extremely acrimonious; and, when applied to the skin, they first inflame, and afterwards excoriate the part, raising a more perfect blister than any of the vegetable acrids, and occasioning a more plentiful discharge of serum.

Cantharides, taken internally, often occasion a discharge of blood by urine, with exquisite pain. If the dose is considerable, they seem to inflame and exulcerate the whole intestinal canal; the stools become mucous and purulent; the breath fetid and cadaverous; intense pains are felt in the abdomen; the patient faints, grows giddy, raving mad, and dies. All these terrible consequences have sometimes happened from a few grains. When taken internally, their action is very uncertain; and the utmost precaution is required in administering them, as frequent instances have been known of an over-dose causing immediate death.

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* When they are pulverized for medicinal purposes, the operator covers his head with a cloth, to prevent any portion entering the mouth, nostrils, or eyes.

HEMIPTERA.

The insects of this order exhibit considerable difference with regard to wings. In some, the upper wings are true elytra, crustaceous, or coriaceous, with membranaceous extremities overlapping; while, in others, the upper wings are wholly membranaceous. In some, the males only are winged, or all are apterous. They agree, however, in the characters exhibited by the parts of the mouth. These are formed for sucking; the labium is produced, with a canal on its upper surface, and consists of several joints. The mandibulæ and maxillæ appear like four hairs, which, by their union, form the haustellum. The labrum is more or less produced as a covering to the base of these organs, and the palpi are nearly obliterated. The metamorphosis is here semi-complete.

THE BLATTA, OR COCK-ROACH TRIBE.

The American Cock-Roach is very frequent on the New Continent, and has sometimes been found in Europe. In South America, particularly in Surinam, it causes great devastation in the houses, by gnawing the stuffs, cloths, and wool, and devouring and injuring the provisions.

According to Reaumur, the American Cock-Roaches have for an enemy a large species of sphex. When one of these spheges encounters a Cock-Roach, it seizes it by the head, pierces it with its sting, and then carries it to its hole, the nidus, where, no doubt, it has deposited its egg, and where the Cock-Roach serves as nourishment for the future young one.

MANTIS TRIBE.

The Orator Mantis.—The second genus in the order of Hemiptera, is that of *Mantis*, called also *Soothsayer*, from the vulgar idea that it possesses supernatural powers. This idea has originated in the peculiar manner of its holding the fore-legs when sitting, which superstition has construed into an act of prayer; so that, if a bewildered traveller applies to this insect for direction, they ignorantly suppose that he will be guided into the right path, according to which leg the animal first stretches out.

The Hottentots hold the *Mantis precarici* in such veneration, that they consider themselves blessed if it alights on them, and they accordingly pay it a species of adoration. Many of the Indians of South America believe, that these insects grow on trees like leaves; and that, when they have arrived at maturity, they loosen themselves, and crawl or fly away.

The head is unsteady, or, from its continual nodding motion, slightly attached to the thorax. The mouth is armed with jaws, and filiform palpi; the antennæ are setaceous; the four wings membranaceous, and wrapped round the body; the under ones folded. The anterior pair of feet are compressed, dentated on the under side like a saw, and terminated by a single crotchet; the four hindermost are formed for advancing slowly. The thorax is extended considerably, narrow, and throughout equal. Its colour is of a brownish green; the young ones more green, the old more brown. It deposits its eggs in a hemispherical parcel, flat on one side; in the parcel are two rows of oblong eggs transversely, and one longitudinal row of shells, as a roof, which cover the joining of the rows. The whole parcel is light, as if composed of thin parchment. It lives from seven to ten years.

"The Mantis is so divine a creature," says the translator of Mouffet, "that if a child has lost its way, and inquires of the Mantis, it will point out the right path with its paw." Dr. Smith, in his tour on the continent, received the following account of the Mantis:—A gentleman caught a male and female, and put them together in a glass vessel: the female soon devoured the head and upper parts of her companion, and afterwards all the remainder of the body.

Roesel, in order to observe the gradual progress of these creatures to the winged state, placed a bag, containing the egg, in a large glass, which he closed, to prevent their escape. From the time they werefirst hatched, they exhibited marks of a savage disposition. He put different sorts of plants into the glass, but they refused them, for the purpose of preying on one another. This determined him to supply them with insect food. He put several ants into the glass to them: but they then betrayed as much cowardice as they had before done of barbarity; for the instant the Mantes saw the ants, they attempted to escape in every direction. This was evidently an instinctive fear of a natural enemy. He next gave them some of the common house-flies, which they seized with eagerness in their fore-claws, and tore in pieces. But, notwithstanding their apparent fondness of flies, they continued to destroy each other through savage wantonness. Despairing at last, from their daily decrease, of rearing any to the winged state, he separated them into small parcels in different glasses; but here, as before, the strongest of each community destroyed the rest.

He afterwards received several pairs of Mantes in the winged state. Profiting by his former observations, he now separated them, placing a male and a female together in different glasses; but they still exhibited signs of a rooted enmity to each other, which neither age nor sex could soften. The instant they were in sight of each other, they threw up their heads, brandished their fore-legs, and each waited an attack. They did not long remain in this posture; for the boldest, throwing open his wings with the velocity of lightning, rushed at the other, and often tore it in pieces. Roesel compares the attack of these creatures to that of two hussars; for they dexterously guard and cut with the edge of the fore-claws, as those soldiers do with sabres; and sometimes at a stroke one of them cleaves the other through, or severs its head from the thorax. After this, the conqueror always devours his vanquished antagonist.

The Mantis frequently watches his prey for some hours, and seldom gives up the object without making the most desperate attempts. There are several other species of this tribe.

The *gongylodes,* in shape, is very extraordinary, being narrow and long; the head is small, flat, with two filiform short antennæ; on the sides of the head are two large polished eyes. The thorax is subciliated, long, narrow, margined, with a longitudinal rising in the middle, and a transverse depression at one-third of its length. The elytra, which, crossed, cover two-thirds of the insect, are veined, reticulated, and the wings are veined and diaphanous. The hinder legs are very long, the middle ones shorter; and the foremost pair of thighs are terminated with spines, the others winged, with membranaceous lobes. The top of the head is awl-shaped, membranaceous, often split at the extremity. From its slender limbs, narrow body, and shrivelled wings of a deadish green when dried, it might be mistaken for a bunch of dead leaves; and this circumstance has obtained it the name of the Walking Leaf. This species is found in China, and the rest are all natives of foreign climes.

LECTURE XLIV

INSECTS, *(continued.)*

GRYLLUS, THE LOCUST.

THESE insects leap by their hinder legs, being strong and much longer than the fore-ones. Their walk is heavy, but they fly tolerably well. Their females deposit their eggs in the earth, by the appendices in their tail, which consist of two laminæ, and penetrate the ground. They lay many eggs, a kind of group, united in a thin membrane. The little larvæ from them are wholly like the perfect insects, except in size, and not having wings or elytra, but only four knobs, which contain both, but undisplayed. Their unfolding takes place only at the metamorphosis when the insect has attained its full growth. In these insects, examined internally, besides the gullet, we discover a small stomach, with a very large one behind, wrinkled and furrowed; and, lower down, a third; so that it is probable all these animals chew the cud, as they closely resemble ruminant animals in their internal conformation.

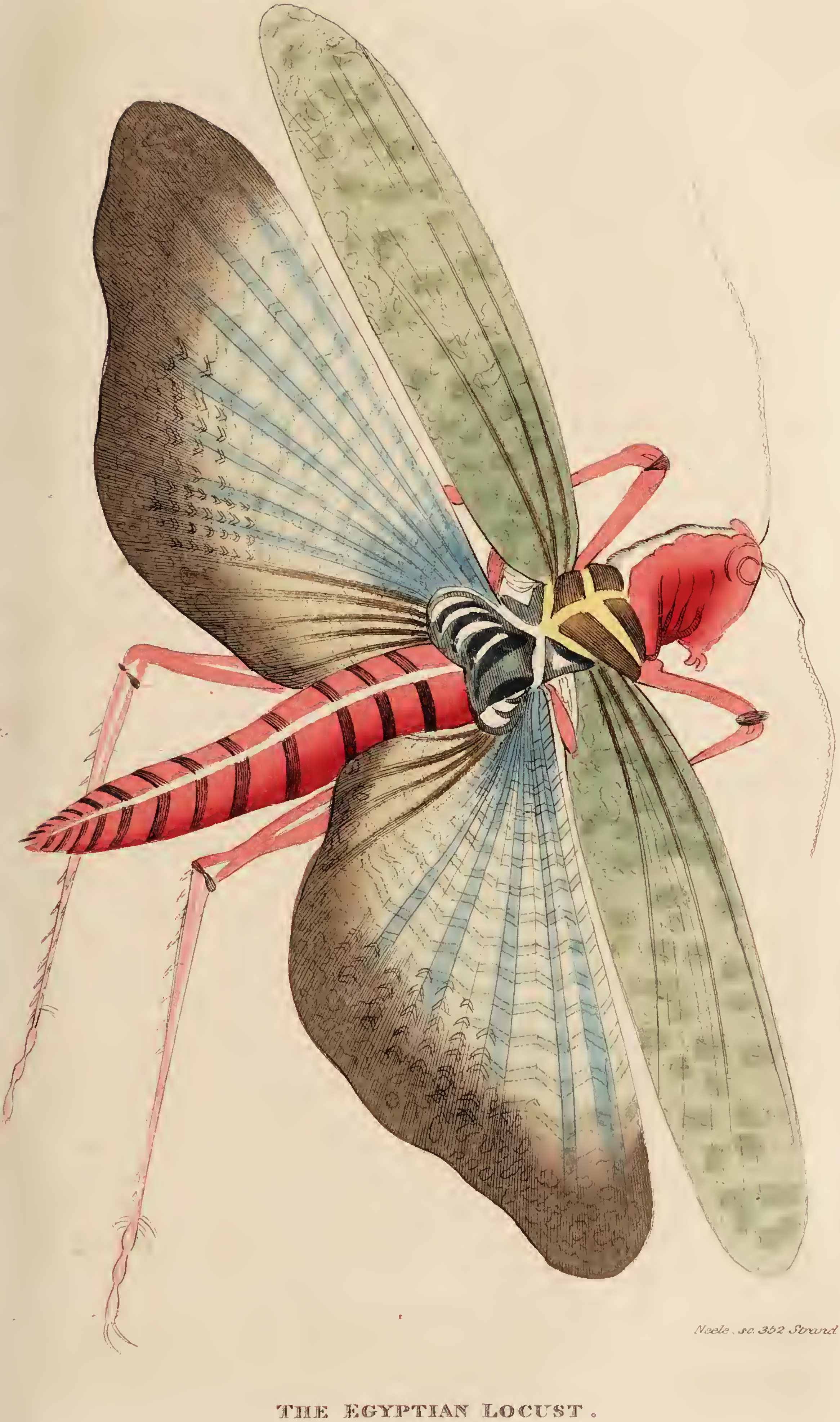
LOCUSTÆ, (the *Grylli* of Fabricius,) or Locusts, are unarmed at the tail. This family is distinguished by having the tail purple, without the setæ of the cricket, or the tube of the grasshopper; their antennæ are filiform, and half shorter than the abdomen; they have three stemmata, and three joints to the tarsi. The *gryllus locustra grossus,* has the antennæ of a cylindrical form: few species vary so much in size and colours. Some of these insects are twice as long as others; the antennæ in most are filiform, but in this particular species cylindrical, of about twenty-four articulations, and but one-fourth as long as the body. The small individuals are nearly red, spotted with black, with the under part a greenish yellow: the larger subjects are all greenish, the under part of a deep yellow, only the inside of the hinder thighs is red; the thorax has above a longitudinal elevation, with one on each side; the middle drawing nigh to the first, forms a kind of X. Between the claws that terminate the feet are small sponges, but larger in this species than the rest. It is very common in the country. The larvæ much resembles the perfect insects, and commonly dwell under ground.

Their distinction into families is proper; as their difference of organization seems adapted to the mode and places in which the insects lay their eggs. Those which have their abdomen furnished with the tube or dart, lay their eggs in a stiff sort of earth, which that instrument perforates. During the operation, the dart opens; and being hollow and grooved within each side, the egg slides down the grooves, and is deposited in the hole. Of those which have the tail without dart, some have long wings, and others very short. The former lay their eggs on the bare ground, and cover them with a glutinous substance which fixes them to the soil, and prevents their being injured either by wind or wet. Those again which have short wings deposit their eggs in the sand in holes made for this purpose, by elongating and retracting the abdominal rings, for they can turn their body as on a pivot; which operation long wings would have materially impeded.

The annals of most warm countries record devastations produced by locusts, which sometimes appear in clouds of vast extent. They seldom visit Europe in such swarms as formerly; yet in the warmer parts are still formidable. Those which have at uncertain intervals visited Europe, are supposed to have come from Africa. They are a large species, about three inches long; the head and horns brownish, blue about the mouth, and the inside of the larger legs; the shield on the back greenish; the upper side of the body brown, spotted black; and the under side purple; the upper wings brown, with small dusky spots, and one large spot at the tips; the under wings transparent, of a light brownish green, and a dark cloud of spots near the tips. These insects are bred in the warm parts of Asia and Africa, whence they have often taken flight into Europe, and committed great devastations. They multiply quicker than any other animals, and are truly terrible where they breed. Some were seen in different parts of Britain, in 1748, and great mischief was apprehended: but, happily, our cold climate, and humid soil, are very unfavourable to their production; so that, being only animals of a year's continuance, they all perished without leaving a young generation to succeed them. —When the locusts take the field, they seem to have a leader, whose flight they observe, and strictly regard all his motions. At a distance they appear like a black cloud, which, as it approaches, gathers upon the horizon, and almost hides the light of day. Sometimes the husbandman sees this imminent calamity pass over without injuring him, and the whole swarm proceeds onward to some less fortunate country; however, where they alight, they destroy every green thing, strip the trees of their leaves, and devour the corn and grass. In the tropical climates they are less pernicious than in the southern parts of Europe; as in the first, the power of vegetation is so strong, that an interval of three or four days repairs the damage; but in Europe this cannot be done till next year.—Besides, in their long flights hither, they are famished by the journey, and are, therefore, more voracious wherever they settle: and as much damage is occasioned by what they destroy, as by what they devour. Their bite contaminates the plant, and either destroys or greatly weakens its vegetation. The husbandmen say they burn whereever they touch, and leave marks of their devastation for three or four years ensuing. When dead, they infect the air so that the stench is insupportable. In the year of the world 3800, Africa was infested with a multitude of locusts. After eating up every thing green, they flew off and were drowned in the sea; where the stench could not have been equalled by the putrifying carcases of 100,000 men.

In 1650, a cloud of locusts entered Russia, in three different places; from thence they spread over Poland and Lithuania, in such astonishing multitudes, that the air was darkened, and the earth covered with their numbers; in some places they lay dead to the depth of four feet; in others, they covered the surface like a black cloth; the trees bent with their weight; and the damage the country sustained exceeded computation.

In Barbary, their numbers are formidable. Dr. Shaw witnessed their devastations in 1724. Their first appearance was in March; the wind had been



Neele. sc. 352 Strand.

THE EGYPTIAN LOCUST.

London, Published by Sir R. Phillips & C.º Feb. 10. 1823.

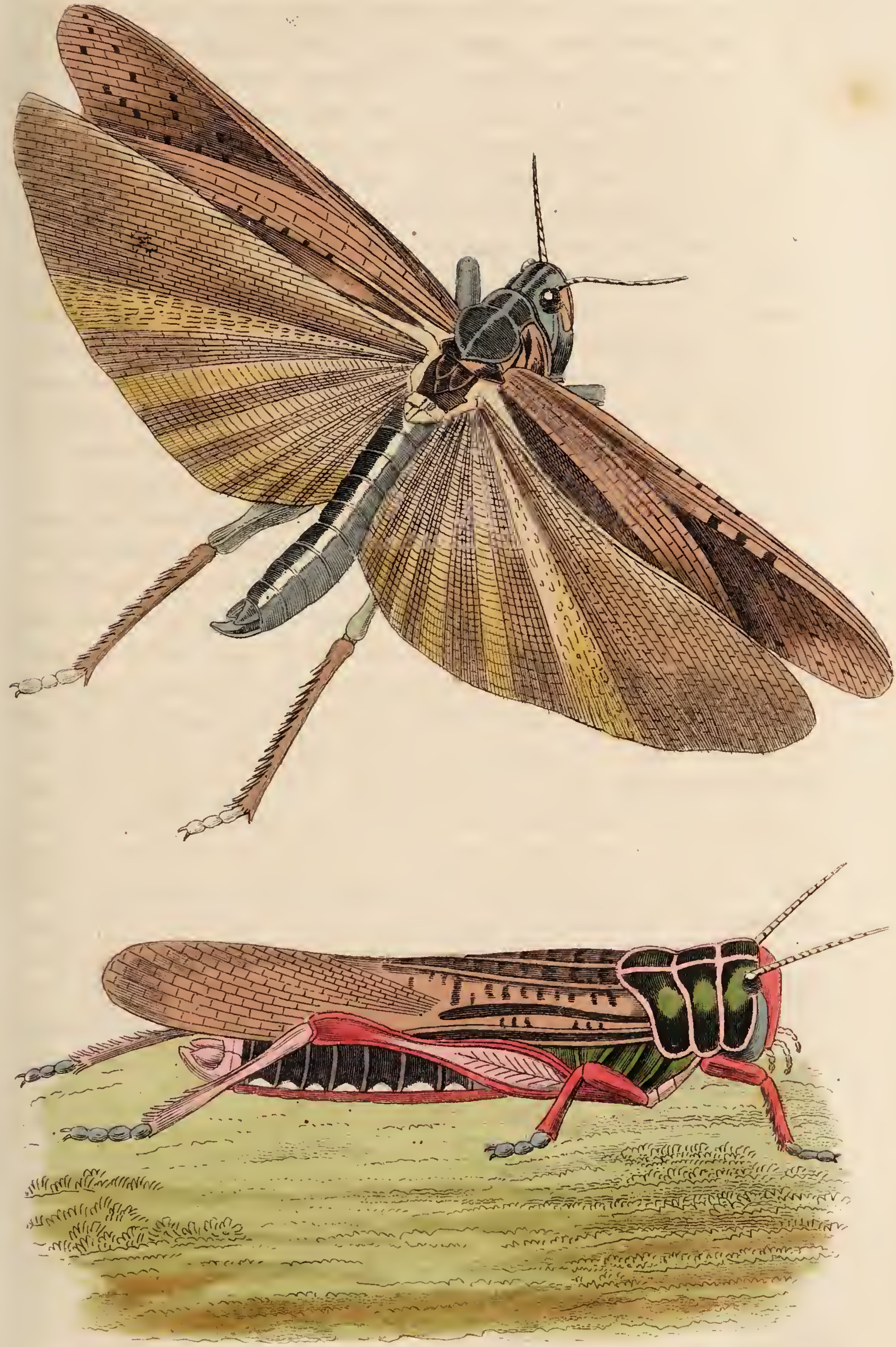
southward some time. In April, their numbers were so increased that, in the heat of the day, they formed large swarms like clouds, and darkened the sun. In the middle of May they began to retire into the plains to deposit their eggs; in June the young brood began to appear, forming many compact bodies of several hundred yards square; which afterwards marching forward, climbed the trees, walls, and houses, eating every thing green in their way. The inhabitants, to stop their progress, cut trenches all over their fields and gardens, which they filled with water. Some placed large quantities of heath, stubble, and other combustible matter, in rows, and set them on fire at the approach of the locusts; but all to no purpose; the trenches were quickly filled, and the fires put out by the numerous swarms that succeeded each other. A day or two after one of these motions, others just hatched came to glean, gnawing off the young branches, and the very bark of the trees. Having lived thus, near a month, they arrived at their full growth, and threw off their worm-like state, by casting their skins; preparatory to this change, they fixed their hinder part to some bush, or twig, or corner of a stone; and immediately, by an adulating motion, their heads would appear first, and soon after their bodies. The whole transformation was performed in seven or eight minutes, after which they remained a little while in a languishing condition; but, as soon as the sun and air had hardened their wings, and dried up the moisture left on casting their sloughs, they resumed their former greediness, with addition of both strength and agility. They did not, however, continue long in this state before they were entirely dispersed. After laying their eggs, they directed their course northward, and probably perished in the sea.

In Barbary, however, the fertility of soil and warmth of climate generally render their depredations of little consequence; besides that, many circumstances concur to diminish their number. Though naturally herbivorous, they often fight, and the victor devours the vanquished; they are the prey, too, of serpents, lizards, frogs, and the carnivorous birds; they have been found in the stomachs of the eagle and different kinds of owls; and they are used as food by the Moors; who hunt them, fry them in oil or butter, and sell them publicly at Tunis and other places.

In 1754, 55, 56, and 57, great devastations were committed in Spain by locusts. They are thus described by Don Guillermo Bowles. "The locusts are seen in the southern parts, particularly in the pastures and remote uncultivated districts of Estremadura, but in general are not noticed if not very numerous, as they commonly feed upon wild herbs, without preying upon gardens and cultivated lands, or making their way into houses. The peasants view them with indifference while they frisk about in the field, and neglect any measure to destroy them, till the danger is immediate, and the favourable moment to remedy the evil is elapsed. Their annual number is not considerable, as the males are more numerous than the females; was an equal proportion allowed only for ten years, their numbers would be so great as to destroy the whole vegetative system. Beasts and birds would starve, and even mankind become a prey to their ravenous appetites. In 1754, their increase was so great from the multitude of females, that all La Mancha and Portugal were covered and totally ravaged by them. The horrors of famine were spread even farther, and assailed the fruitful provinces of Andalusia, Murcia, and Valencia.

The female, passes her days in some solitary place, in forming a retreat under ground, where she can secure her eggs, of which she lays about forty, screening them from the inclemency of the air, as well as the more immediate danger of the plough or spade, one fatal blow of which would destroy all the hopes of a rising generation.

The manner of building this cell is equally surprising. In the hinder part of her body, nature has provided a round smooth instrument, eight lines long, its head the size of a writing quill, diminishing to a hard sharp point, hollow like the tooth of a viper, but only visible with a lens; at its root is a cavity, with a bladder of glutinous matter, the same in colour,



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THE MIGRATORY OR WANDERING LOCUST.

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but not the consistency or tenacity of the silk-worms; and the orifice corresponds with the instrument to eject the matter. It is hid under the skin, and its interior surface is united to the moveable parts of the belly, and partakes its motions, forming the most admirable contexture for its operations, as she can dispose of it at pleasure, and eject the fluid, which has three very essential properties; being indissoluble in water, it prevents the young being drowned; it resists the heat of the sun, else the structure would give way and destroy its inhabitants; it is proof against the frost of winter, and thus preserves a necessary warmth within. For greater security, this retreat is always in a solitary place; for, though a million locusts were to alight on a cultivated field, not one would deposit her eggs there; but wherever they find a barren and lonesome situation, there they repair and lay their eggs.

These locusts seem to devour less from a ravenous appetite than a rage of destroying every thing in their way. They are fond of juicey plants and fruits, as melons, and all garden fruits and herbs, also aromatic plants, lavender, thyme, rosemary, &c.; but what is very singular, they equally eat mustard-seed, onions, garlic, and even hemlock, and the most rank and poisonous plants, as the thorn-apple and deadly night-shade. They will prey upon crowfoot, whose causticity burns the hides of beasts; and such is their universal taste, that they regard alike the innocent mallow, or the bitter furze, rue, or wormwood, consuming all without predilection or favour; with this remarkable circumstance, that, during the four years they committed such havoc in Estremadura, the love-apple *(lycopersicon solanum* of Linnæus,) was the only plant that escaped their rapacious tooth, and claimed a respect to its root, leaves, flowers, and fruit. Millions of them lighting on a field near Almaden, devoured the woollen and linen garments of the peasants. The curate of the village asserted, that a tremendous body entered the church, devoured the silk garments that adorned the images of the saints, and did not even spare the varnish on the altars. In order to discover the nature of such a phenomenon, the stomach of the locust was examined, but only afforded one thin and soft membrane, with which, and the liquor it contains, it destroys and dissolves all kinds of substances, equally with the most caustic and venomous plants; extracting a sufficient and salutary nourishment.

Curiosity to know the nature of so formidable a creature, urged him to an exact examination of all its parts; its head is of the size of a pea, though longer; its forehead pointing downwards, like the handsome Andalusian horse; mouth large and open; eyes black and rolling, added to a timid aspect not unlike a hare. Its two jaws have four incisive teeth, whose sharp points traverse like scissars, their mechanism being such as to gripe, or cut. Thus armed, what can resist a legion of such enemies? After devouring the vegetable kingdom, were they, in proportion to their strength and numbers, to become carnivorous, like wasps, they would be able to destroy whole flocks of sheep, even to the dogs and shepherds; just as ants in America overcome the fiercest serpents.

The locust spends April, May, and June, in the place of its birth; at the end of June its body is strong, and its wings have a fine rose colour. Being then in their prime, they assemble for the last time, to propagate their species; the morning is spent in the courtship of the one, and the retreat of the other. When the warmth has cleared their wings from the dampness of the night, the males continue their pursuit, and rise with the females 500 feet high, forming a black cloud that darkens the solar rays. The clear atmosphere of Spain becomes gloomy, and the finest summer day of Estremadura more dismal than the winter of Holland. The rustling of so many millions of wings in the air, resembles the trees of a forest agitated by the wind. The first direction of this formidable column is always against the wind which if not too strong, the column will sometimes extend about two leagues; the locusts then make a halt, when the most dreadful havoc begins; their sense of smell being so delicate, they can find, at that distance, a corn-field or a garden; and, after demolishing it, they rise again in pursuit of another; this may be said to be done in an instant. Each seems to have four arms and two feet; the males climb up the plants, as sailors ascend the shrouds of a ship, and nip off the tenderest buds, which fall to the females below.

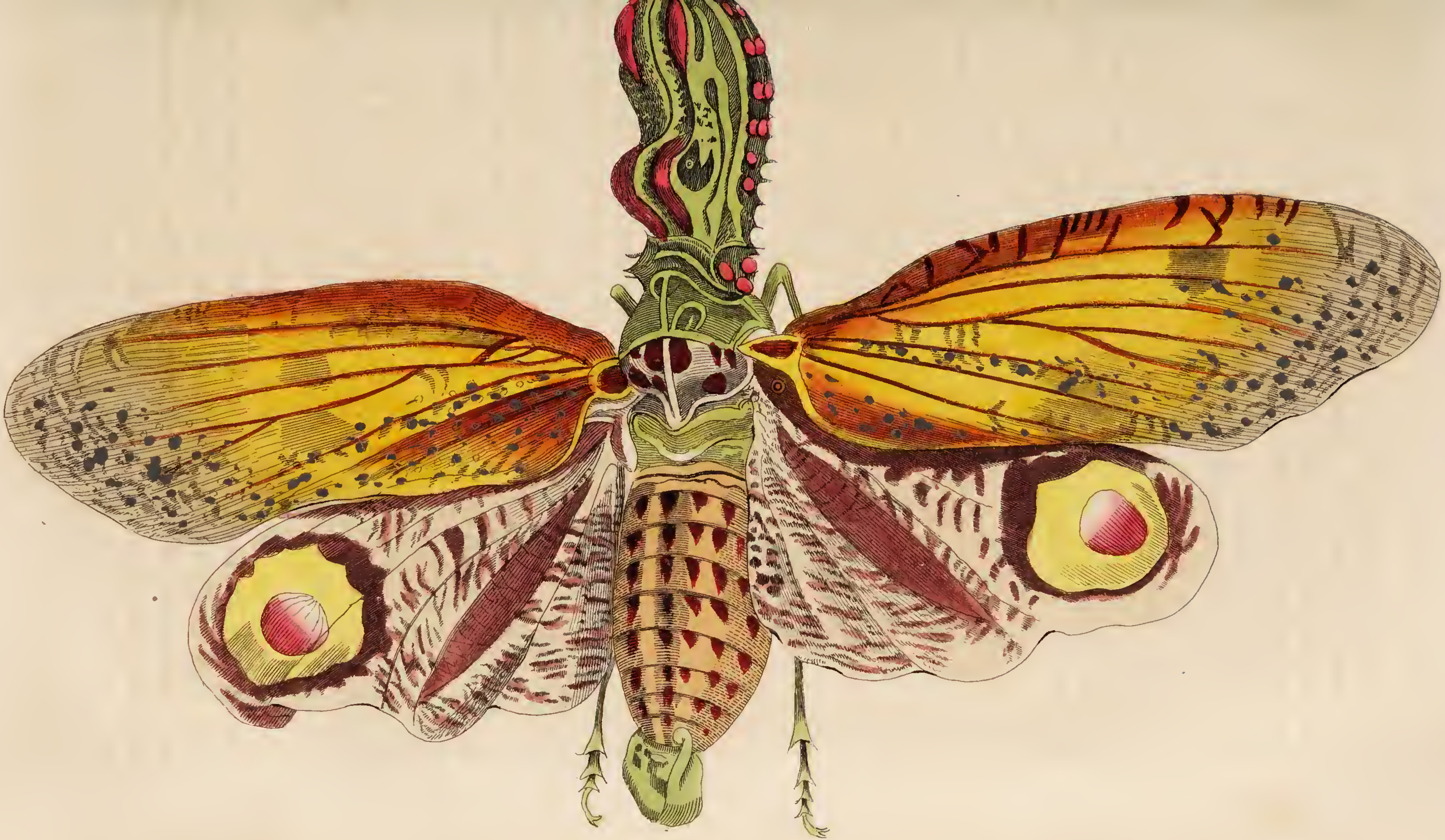
The locusts found in the pasture-grounds of Estremadura, are indigenous, differing in shape from those of the North, or the Levant, on comparing them with such in cabinets of natural history. The locust of Spain only has rose-coloured wings; besides, they cannot possibly come from any other part. A cloud of them is said to have once passed over Malaga, towards the sea, and went over it about a quarter of a league, to the great joy of the inhabitants, who concluded they would soon be drowned; but, to their disappointment, they suddenly veered about towards the coast, and settled upon an uncultivated space, surrounded with vineyards, which they soon after quitted. When once they appear, be the number demolished ever so great, the proportion remaining is still very considerable; the only way therefore, to put an end to such a calamity, is, by destroying their eggs, by which means they might be totally extirpated.

"Many," Mr. Forbes says, "when separately viewed, are extremely curious, and very pleasing; but, considered collectively, as destroyers of a country, they appear in an awful light. Desolation and famine mark their progress; all the expectations of the husbandmen vanish; his fields, which the rising sun beheld covered with luxuriance, are, before evening, a desert; the produce of his garden and orchards is equally destroyed; for, where these destructive swarms alight, not a leaf is left upon the trees, a blade of grass in the pasture, nor an ear of corn in the field: all wears the marks of dreadful devastation; to be renewed no more until the next rainy season. The locusts not only cause a famine, by destroying the produce of the country, but in districts near the sea, where they had been drowned, they have occasioned a pestilence, from the putrid effluvia of immense numbers blown upon the coast, or thrown up by the tides. It is not a few fields, or only two or three villages, that are ruined by these voracious creatures; the face of the country is covered with them for many miles; yet in India they are not near so pernicious as in Arabia, and many parts of Africa, where they prove a scourge of the severest kind. Soon after my arrival at Baroche, I saw a flight of locusts extending above a mile in length, and half as much in breadth; they appeared, as the sun was in the meridian, like a black cloud at a distance; as they approached from the east, the density of the host obscured the solar rays, cast an awful gloom, like that of an eclipse, over the garden, and caused a noise, like the rushing of a torrent. They were near an hour in passing over our little territory; I need not say with what an anxious eye we marked their progress, fearful lest the delicacies of our garden should allure them to a repast. We picked up a few stragglers, but the main body took a western direction, and without settling in the country, most probably perished in the gulph of Cambay. A few months afterwards a much larger army alighted on the opposite side of the Nerbudda, destroyed every vegetable production throughout the Occlaseer purgunna, and gave the whole country the appearance of having been burnt.

"I am surprised that commentators on the Scriptures have perplexed themselves about the food of John the Baptist in the wilderness; which we are informed consisted of locusts and wild honey; and for which the cassia-fistula, or locust-tree, and many other substitutes, have been mentioned: but it is well known that locusts are an article of food in Persia and Arabia, at the present day; they are fried until their wings and legs fall off, and in that state are sold in the markets, and eaten with rice and dates, sometimes flavoured with salt and spices: and the wild honey is found in the clefts of the rocks in Judea, as abundantly as in the caves of Hindostan."

GREAT LANTERN FLY.

This insect is common in many parts of South America, and is thus described by Madam



GREAT LANTHORN OR FIRE FLY.

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Neele & Son 352 Strand

Merian, in her superb work on the insects of Surinam:—

"The Indians once brought me, (says she,) before I knew that they shone by night, a number of these Lantern-flies, which I shut up in a large wooden box. In the night they made such a noise, that I awoke in a fright, and ordered a light to be brought, not being able to guess whence the noise proceeded. As soon as I found that it came from the box, I opened it, but was still more alarmed, and let it fall to the ground in my fright, at seeing a flame of fire issue from it; and as many animals as came out, so many different flames appeared. When I found this to be the case, I recovered from my alarm, and again collected the insects, much admiring their splendid appearance." The light, she adds, of one of these insects is so bright, that a person may see to read a newspaper by it. The front, or fore-part of the head, is drawn extended and empty; the antennæ are seated below the eyes, having two articulations; the exterior larger and globular; the rostrum is inflected, or bent inwards under the body; and the feet are made for walking. The species most remarkable, is, the candelaria, or *lantern-fly*. The head and thorax are generally of a ruddy brown; and the ground colour of the elytra is fresh green, but quaintly figured with spots of a yellowish clay colour, sometimes pale, at other seasons of a deeper hue. The wings are of a deep and beautiful yellow, with a broad band of glossy black, bordering the extremities. The tarsi are composed of three articulations, and of a paler brown than the legs and thighs. When the insect is on the wing, the waving of the elytra (whose thinness renders the spots thereon transparent), assisted by the luminous quality peculiar to the tribe, and the golden yellow of the under-wings, bordered with black, occasion the flashes they dart around in the night, and create images beyond probability in the minds of persons too ready to credit hyperboles. Several other species, natives of China and India, are also enriched with the most lively colours.

CICADÆ IN GENERAL.

Several species of these insects were known to the antients, who regarded them as the emblems of eternal youth. The Athenians wove golden Cicadæ in their hair, to denote their national antiquity, or that, like these creatures, they were the first-born of the earth. The shrill musical note of these insects has been celebrated both by ancients and moderns; and Shaw, in his account of insects, commemorates the circumstance by the following elegant translation from Anacreon:—

Happy insect! blithe and gay,
Seated on the sunny spray,
And drunk with dew, the leaves among,
Singing sweet thy chirping song!

All the various seasons' treasures,
All the products of the plains,
Thus lie open to thy pleasures,
Fav'rite of the rural swains.

On thee the Muses fix their choice,
And Phœbus adds his own,
Who first inspired the lively voice,
And tun'd the pleasing tone.

Thy cheerful note, in wood and vale,
Fills every heart with glee;
And summer smiles with double charms,
While thus proclaimed by thee.

Like gods canst thou the nectar sip,
A lively, chirping elf;
From labour free, and free from care,
A little god thyself.

The Cicadæ are found in various parts of the new and old continent, (see vol. 3.) where they subsist on leaves and other vegetable substances. Those of the hottest climates make the loudest noise. According to Mr. Smeathman, who resided a considerable time in Africa, it appears that some are to be heard half a mile distant; and that the singing of one of them in a room, will immediately silence a whole company. Professor Thunberg says, that one of the Javanese species makes a noise as shrill and piercing, as if it proceeded from a trumpet.

The vocal sound uttered by the Cicadæ proceeds from a curious organ under the abdomen, composed of several membranaceous valves, put in motion by a powerful set of muscles, which is peculiar to the male, the female being entirely mute.

THE WAX-FORMING CICADÆ.

The insects are white when young, and when they make their wax. When old, they are of a blackish chesnut colour, and form little pelotons on the branches of trees. At first, each of these are of the size of a grain of millet; towards the beginning of spring they increase in bulk, and spread: they are attached to the branches like grapes, and, at first sight, the trees that bear them, appear loaded with fruit. About the beginning of May the inhabitants gather them, and suspend them to the trees enveloped in broad-leaved grass. In June and July the pelotons open, and the insects come forth, crawl about the leaves, and form their wax.

The wing-cases of this insect are green, margined with red, and deflexed; and the interior ones are spotted with black. In the variety figured and described by Sir George Staunton, these are whitish, margined with black, and have a row of black spots on the posterior edge.

The larvæ are elegant and beautiful creatures, and to their labours the Chinese are indebted for fine white wax. They form a white grease, which adheres to the branches of trees, hardens, and becomes wax. In the autumn it is scraped off, melted, and strained. Mixed with oil, it is used to make candles; and, for this purpose, it is considered superior to bees-wax.

THE AMERICAN LOCUST.

This is a species of Cicadæ, very common in Pennsylvania; but, at certain periods, the swarms are so immense, that it is called a Locust. (See vol. iii.)

In April they emerge from the ground: on their first coming out they are in the chrysalid state; but the back soon bursts, and the flying insects disengage themselves. At first they are entirely white, with red eyes, and very weak and tender; but they soon attain their full strength, being of a dark brown colour, with four finely variegated transparent wings.

Vast swarms were bred, or came into the island of Barbadoes, in the year 1734-5, which destroyed almost every green and tender plant. So great was the destruction, and such the scarcity of food occasioned by them, in the parish of St. Philip, that a collection was made for the sufferers through the rest of the island. The Indians are said to pluck off their wings, and boil the bodies for food.

CICADA PLEBEIA, THE CLASSICAL CICADA.

This insect is a native of the warmer parts of Europe, and particularly of Italy and Greece. They proceed from eggs deposited by the parent in and about the roots of trees; and they hatch into larvæ, which, when grown to the full size, are the *tettigometræ* of the ancient writers. They, however, differ in their opinions relative to the Cicadæ. Virgil speaks of them as insects of a disagreeable and stridulous tone; while Anacreon compliments them on their musical note, and makes the Cicadæ a favourite of Apollo. Notwithstanding these attestations in favour of the Cicadæ, modern ears are offended, rather than pleased, with its voice; which is so strong and stridulous, that it fatigues by incessant repetition; and a single Cicadæ, shut up in a cage, has been found almost to annoy the whole of the company.

CIMECES, OR BUGS IN GENERAL.

Linnæus enumerates 121 species, to which several have been added by other naturalists. A very peculiar species was discovered at the Cape, by Dr. Sparman, named *Cimex paradoxus;* observed as at noontide he sought shelter among the branches of a shrub from the intolerable heat of the sun. Though the air was extremely still and calm, so as scarcely to have shaken an aspen leaf, yet he imagined he saw a little withered, pale, crumpled leaf, eaten by caterpillars, flittering from the tree. On examination, he saw a live insect, in shape and colour resembling the fragment of a withered leaf, whose edges were turned up and eaten away by caterpillars; and yet all over beset with prickles. Nature, by this peculiar form, certainly has extremely well defended and concealed, as in a mask, this insect from birds and other foes; in all probability, to preserve and employ it for some important office in the system

The larvæ of bugs only differ from the perfect insect by the want of wings; they run over plants; and grow, and change to chrysalids, without appearing to undergo any material difference. They have only rudiments of wings, which the last transformation unfolds, and the insect is then perfect. In the two first stages, they are unable to propagate their species; in their perfect state, the female, fecundated, lays a number of eggs, often upon plants; many of which, through a magnifier, present singular varieties of configuration. Some are crowned with a row of small hairs; others have a circular fillet; and most have a piece which forms a cap, which the larva pushes off when it forces open the egg. Released from their prison, they overspread the plant on which they feed, extracting, by the rostrum, the juices appropriated for their nourishment; yet, even in this state, the larvæ are not peaceably inclined; some are very voracious, and spare neither sex nor species they can conquer. In their perfect state they are cannibals, glutting themselves with blood; they destroy caterpillars, flies, and even the coleopterous tribe, whose hard elytra might be supposed proof against their attacks, have fallen an easy prey to their sharp piercing rostrum, and the incautious naturalist may experience a feeling severity of its nature. The (cimex lectularius) house-bug, is particularly acceptable to the palate of spiders; and is even sought by wood-bugs; which is not indeed surprising, when their general voracity is considered.

It is said that house-bugs were first introduced into England, in the timber brought over to rebuild London after the great fire of 1666; and that, previous to that period, they were unknown in England.

COCCUS, OR COCHINEAL INSECTS.

The most remarkable species of this genus are:

1. The *coccus hesperidum*, or *green-house bug*,—oval, oblong, of a brown colour, covered with a varnish; with six legs, a notch, and four bristles at the tail. It infests orange trees and similar plants in green-houses. When young it runs upon the trees; but afterwards fixes on some leaf, where it hatches an infinity of eggs, and dies. The male is a very small fly.

2. The *coccus phalarides:* the male is small; its antennæ are long; the feet and body are of a reddish colour, nearly pink, and sprinkled with white powder. Its two wings, with four snow-white threads of its tail, two being longer than the other. It is found upon the gramen, called *phalaris*. The female contrives, along the stalks of that dog-grass, little nests, of a white cottony substance, in which she deposits her eggs. The small threads of her tail are scarcely perceptible.

3. The *coccus cacti*, a native of the warmer parts of America, is the *cochineal* animal, so highly valued for its incomparable red colour, which it readily communicates to wool and silk, but with difficulty to linen and cotton. The two sexes are exceedingly dissimilar in appearance.

The female alone is valuable for its colour, is ill-shaped, tardy, and stupid: its eyes, mouth, and antennæ, are fixed deep, and so concealed in the folds of the skin as only to be distinguished by a microscope. The male is scarce, and sufficient for 300 females; it is active, small, and slender; its neck is narrower than the head and the rest of the body. Its thorax is elliptical, longer than the neck and head together, and flattened below; its antennæ are jointed, and out of each joint issue long slender hairs, disposed in pairs on each side. It has six feet, each formed of distinct parts. From the posterior extremity of its body two large bristles are extended, four or five times its length. It bears two wings, fixed to the upper part of the thorax, which fall like the wings of common flies when it rests. These are of an oblong form, and suddenly diminished in breadth where connected to the body. The male is of a bright red; the female of a deeper colour. They are bred on a plant, known in Oaxaca, in New Spain, and all those parts where it abounds, by the name of *nopal*, or *nopalleca*, the *Indian fig-tree*.

The cochineal insect may be compared to the silkworm, in the manner of depositing its eggs. The insects destined for this purpose are taken at a proper time of their growth, and put into a box well closed, and lined with a coarse cloth, lest any of them should be lost; and in this confinement they lay their eggs, and die. The box is kept close shut till the time of placing the eggs on the nopal, when, if any motion is perceived, it is a sufficient indication that the animalcule has life, though the egg is very minute, and this is the seed placed on the foliage of the nopal, the quantity contained in the shell of a hen's egg being sufficient for covering a whole plant. The principal countries where the cochineal insects are bred, are Oaxaca, Tlascala, Chulula, Nueva Gallicia, and Chiapa, in New Spain; and Hambato, Loja, and Tucuman, in Peru; but only in Oaxaca are they gathered in quantities, and form a branch of commerce; the cultivation of these little creatures being there the chief employment of the Indians. In trade, four sorts

MICROSCOPIC OBJECTS.

The Cossus or Willow Caterpillar.

Fig.1 Fig.3

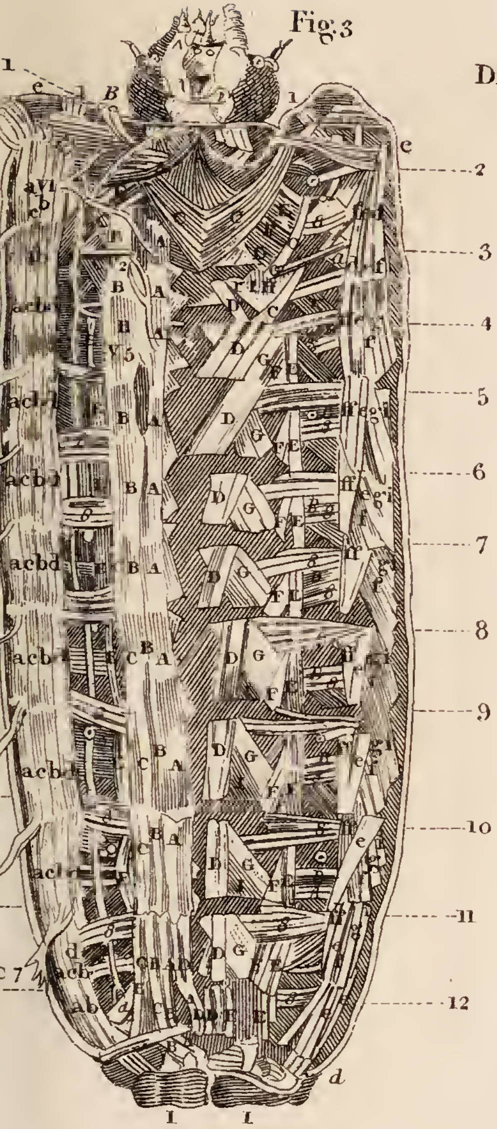
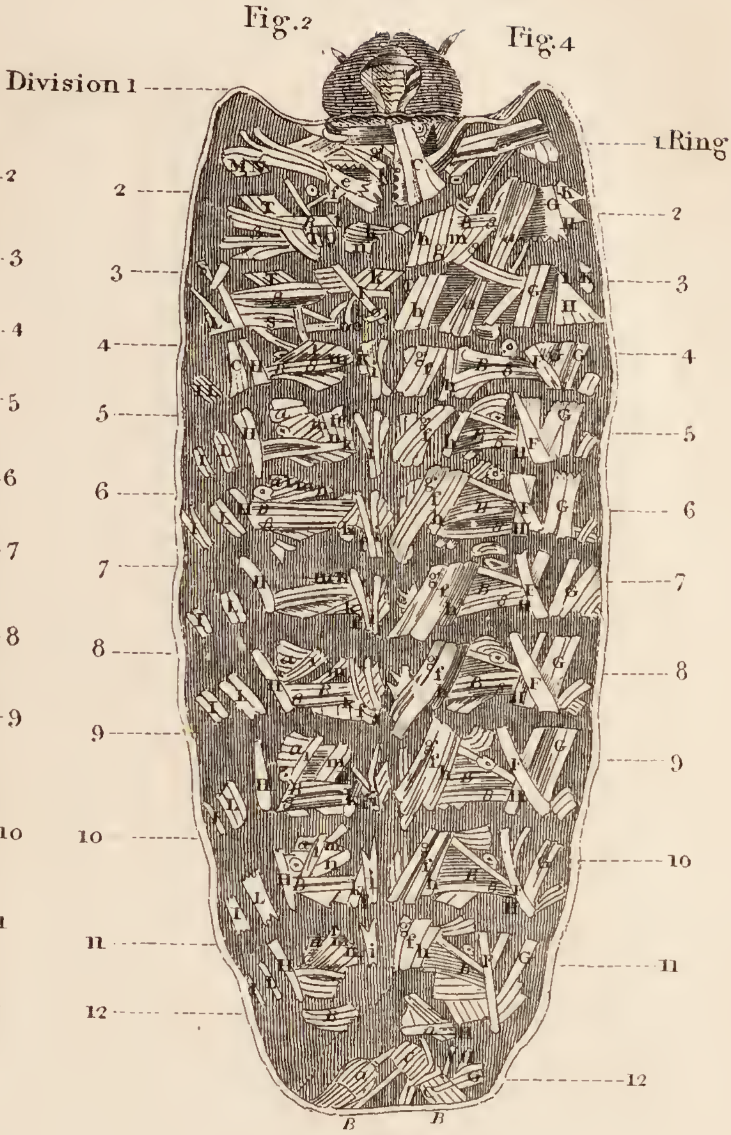


Fig.2 Fig.4



The Head and Body of the Coſsus Caterpillar.

ig.5 Fig.6

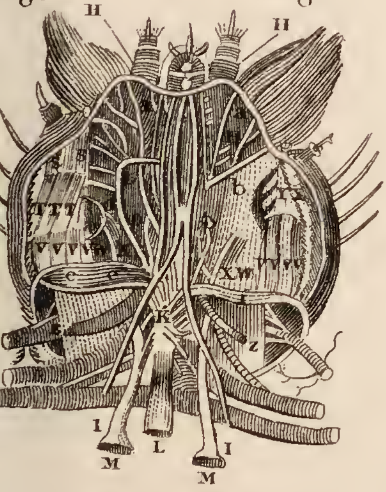
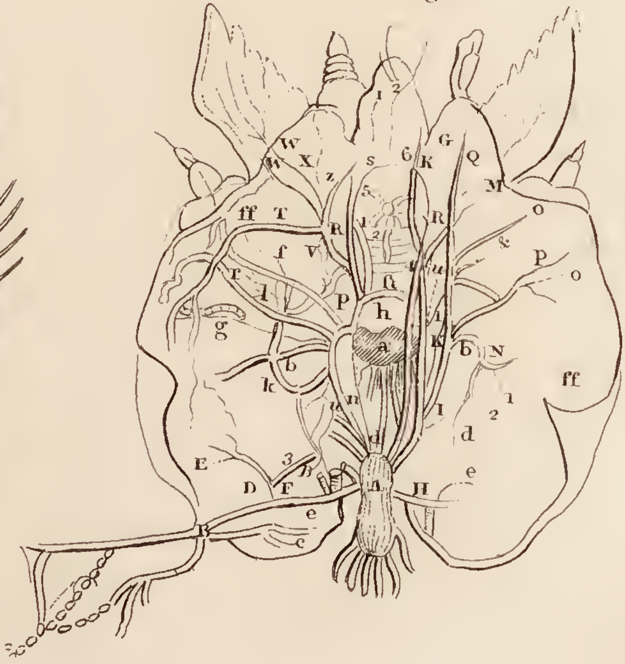


Fig.7



London, Published by Sir R. Phillips & Co. Feb. 10. 1823.

of Cochineal are distinguished, *Mastique*, *Campeschane*, *Tetraschale*, and *Sylvester;* of which the first is accounted the best, and the last of the least value. Its principal consumption is among the dyers.

Two sorts of cochineal are gathered at Mexico; the sylvestris, the Spanish *grana sylvestra*, and the fine, or *grana fina*, Mesteque, from a province of Mexico; and which are bred upon the nopal. The first is smaller, and covered with a cottony down, which increases its weight with a substance useless in dyeing; an equal weight of it, therefore, gives less colour, and is of a lower price than the fine cochineal; but these disadvantages are perhaps compensated by its being reared with greater facility, at less expence, and, by the effects of its down, enabled better to resist rain and storms. This kind, when bred upon the nopal, loses part of its tenacity, and some of its cotton, and acquires double the size it has on the opuntia. It is therefore probable that it would be improved by continued attention, and would approach more to the fine cochineal.

M. Thieri de Menonville, led by his patriotic spirit and personal courage, exposed himself to imminent danger, in observing the mode of rearing the cochineal in Mexico; to obtain thence that valuable production, to enrich the colony of St. Domingo. He brought back both species of cochineal, and nopals, which afford the best food for insects. Upon his return, he employed himself in cultivating the nopal, and different kinds of opuntia, and in rearing the two species of cochineal. On his return to St. Domingo, he discovered the coccinella sylvestris, upon a kind of opuntia there, called *péreschia*, or *patte de tortue*. This discovery did not remain unprofitable; M. Bruley successfully reared this species of cochineal; and communicated the method to the present Royal Society of Arts and Sciences, at Cape François, who have published a posthumous work of M. Thieri de Menonville, which contains minute instructions with regard to every thing that respects the cultivation of the nopal, and the other species of opuntia may be substituted, for breeding or rearing the cochineal.

Two months after the females reserved are sown upon the nopal, the young cochineals issue; and this is the proper season for gathering them, when they are killed by immersion in boiling water. The hot iron plates or ovens, which are sometimes employed, may, by being too hot, injure the cochineal. When taken out of the water, they are carefully dried by exposure to the sun, and lose nearly two-thirds of their weight. When the fine cochineal is dry, it is passed through a sieve sufficiently coarse, but capable of retaining the down and cotton of the male larvæ, which are kept apart, and sold separately, or with the coccinella sylvestris.

Fine cochineal, well dried and properly kept, is of a grey colour, inclining to purple. The grey is owing to a powder which naturally covers it, and a part remains; the purple tinge proceeds from the colour extracted by the water. Cochineal will keep a long time dry. Hellot tried some, 130 years old, which produced the same effect as new.

It had been supposed, that cochineal owes its colour to the red fruit of the nopal, on which it lives; but M. Thieri de Menonville observes, that the nutritive juice is greenish; and that it can live and propagate on such opuntia as do not bear red fruit. It is not easy to form a just idea of the utility of cochineal to St. Domingo, possessed of so many rich productions. M. Thieri de Menonville considers it as a valuable resource for those parts whose unfruitful soil is not adapted to other produce; and for colonists unable to support the expence attending the cultivation of other crops.

The attempts made, deserve so much the more to be pursued and encouraged, as they have for their object an important branch of commerce; and, as enlightened industry has great advantages over ignorant indolence, it will be found less difficult perhaps to naturalize cochineal, at least in hot countries, than it was to naturalize silk-worms. A distinguishing feature between cochineal and madder, may be observed in the manner they are acted upon by re-agents. Both receive a yellow colour from acids; but, if the colouring matter of cochineal be separated by a substance which precipitates it from the acid liquor, it re-appears, with its natural colour little altered; whilst that of madder, treated in the same manner, retains a yellow or fawn tinge. Hence mordants, abounding in acid, as solution of tin, are more successfully employed with cochineal than with madder; because, probably, the colouring matter of madder, united with oxyd of tin, retains a portion of acid; whilst that of cochineal combined with it, either less, or retains none.

Mr. Kerr, who, in the Philosophical Transactions, has given a minute account of these insects, says, that he has often observed their birth, but could never see any of them with wings; nor was he ever able to remark any distinction in the sexes: owing, most probably, to the minuteness of the objects, and the want of proper glasses.

It has been computed, that there are imported into Europe no less a quantity than eight hundred and eighty thousand pounds weight of cochineal, annually.

4. *The Coccus ilicis*, or that forming the kermes grains, inhabits the quercus coccifera of the southern parts of Europe. Hellot says, it is found in the woods of Vauvert, Vandeman, and Narbonne; but more abundantly in Spain, towards Alicant and Valencia.

Both ancients and moderns seem to have had very confused notions concerning the origin and nature of the kermes; some considering it a fruit, without knowing the tree which produced it; others, an excrescence, by the puncture of a particular fly, like the common gall observed upon oaks; but it is ascertained that the kermes is really only the body of an insect, transformed into a grain, berry, or husk, according to the course of nature. The progress of this transformation must be considered at three different seasons. In the first stage, at the beginning of March, an animalcule, no larger than a grain of millet, scarce able to crawl, is perceived sticking to the branches of the tree, where it fixes itself, and soon becomes immoveable; at this period it grows the most, and appears to swell and thrive with the sustenance it obtains. At the second stage, in April, its growth is completed; its shape is then round, about the size of a pea, and it has acquired more strength; the down which covered it is changed into dust, and seems a husk or capsule, full of a reddish juice, like discoloured blood. Its third state is towards the end of May, when the husk appears replete with small eggs, less than the seed of a poppy. These are properly ranged under the belly of the insect, progressively placed in the nest of down that covers its body, which it withdraws in proportion to the number of eggs. After this is performed, it soon dies, though it still adheres to its position, rendering a further service to its progeny, and shielding them from the inclemency of the weather, or the hostile attacks of an enemy. In a good season they multiply exceedingly, having from 1800 to 2000 eggs, which produce the same number of animalcules. In France, poor people let their nails grow, to gather the kermes, and pick them off with greater facility.

5. *The Coccus lacca, or gum-lac animal,* is a native of the East Indies.

The head and trunk form one uniform, oval, compressed, red body, of twelve transverse rings, of the shape and magnitude of a very small louse. The back is carinate; the belly flat; the antennæ half the length of the body, filiform, truncated, and diverging, sending off two, often three, delicate, diverging hairs, longer than the antennæ: the mouth and eyes cannot be seen with the naked eye. The tail is a little white point, sending off two horizontal hairs as long as the body. It has three pair of limbs, half its length. Thus they sally forth from the womb of the parent in November and December. For some time they traverse the branches of the trees upon which they were produced, and then fix upon the succulent extremities of the young branches. By the middle of January all are fixed in their proper situations; and appear plump, but show no marks of life. The limbs, antennæ, and setæ of the tail no longer appear; their edges are environed with a spissid subpellucid liquid, which glues them to the branch: the gradual accumulation of this liquid forms a complete cell for each insect, and is called *gum-lacca.* About the middle of March the cells are completely formed, and the insect appears an oval, smooth, red bag, without life, about the size of a small cuchanical insect, emarginated at the obtuse end, full of a beautiful red liquid, in which, in October and November, are about twenty or thirty oval eggs, or rather young grubs. When this fluid is all expended, the young insects pierce a hole through the back of their mother, and walk off, leaving their exuviæ, that white membranous substance found in the empty cells of the stick-lac.

The insects inhabit four trees: 1. Ficus religiosa, *Linnæi;* 2. Ficus indica, *Linnæi;* 3. Plaso, *Hortus Malabaricus;* and 4. Rhamnus jujuba, *Linnæi.* The insects generally fix themselves so close, and in such numbers, that scarcely one in six has room to complete her cell: the others die, and are eaten up by various insects. The extreme branches appear as if covered with a red dust, and their sap is so exhausted, that they wither and produce no fruit; the leaves either drop off, or turn to a dirty black colour. A red medicinal gum is produced by incision from the plaso tree, so similar to the gum-lacca, that it may readily be mistaken for it. Hence, probably, those insects have little trouble in animalizing the sap of these trees in forming their cells. Gum-lacca is principally found upon the uncultivated mountains on both sides the Ganges, where the only trouble in procuring it is, in breaking down the branches, and carrying them to market. This insect and its cell has gone under the various names of *gum lacca, lack, loc-tree;* in Bengal, *la:* and by the English it is distinguished into four kinds, differently denominated.

Lacca, lac, or gum-lac, is a kind of wax, of which these insects form cells upon trees, like honeycombs. In these cells remain some of the dead insects, which give a red colour to the whole substance of the lac. That called *stick-lac* is the wax adhering to some of the small branches of the tree, and is unprepared. This lac, when separated from the adhering sticks, and grossly powdered, and deprived of its colour by digestion with menstruums, for dyes, and other purposes, is called *seed-lac;* when the stick-lac is freed from impurities, by melting it over a gentle fire, and formed into cakes, it is called *lump-lac;* and, lastly, that called *shell-lac,* is the cells liquefied, strained, and formed into thin transparent laminæ, thus: separate the cells from the branches, break them small, throw them into a tub of water one day, wash off the red water, dry the cells, and with them fill a cylindrical tube of cotton-cloth two feet long, and one or two inches in diameter; tie both ends, turn the bag over a charcoal fire; as the lac liquefies, twist the bag, and, when a sufficient quantity has transuded the pores of the cloth, lay it upon a smooth junk of the plantain-tree, and, with a strip of the plantain-leaf, draw it into a thin lamella; take it off while flexible, for it will be immediately hard and brittle. The value of shell-lac is according to its transparency.

The lac insect is one of the most useful of that tribe yet discovered, particularly to the natives of the countries where it is found. They consume a great quantity of shell-lac in making ornamental rings, painted and gilded in various tastes, to decorate the arms of the ladies; and it is formed into beads, spiral and linked chains for necklaces, and other female ornaments.

6. *Coccus Polonicus*, an insect which may very aptly be called the *cochineal* of the north.

As the cochineal loves only the hot climates, this creature lives only in the cold ones. Though collected for the use of dyers, it is inferior to the true cochineal. It is commonly known by the name of *Coccus Polonicus*, or the *Scarlet-grain of Poland.* It is met with in Poland, and many other northern countries, affixed to the root of a plant, usually that called *Polygonum cocciferum.* Towards the end of June the coccus is in a fit state to be gathered; every one is then nearly spherical, and of a fine violet colour. Some are not larger than poppy seeds; others, the size of a pepper-corn; and each lodged, either in part or entirely, in a sort of cup, like that of an acorn. On some plants are found only one or two of these, and on others more than forty; and they are sometimes placed near the origin of the stalks of the plants.

NEPA, THE WATER SCORPION.

These insects are voracious, and feed on other aquatic animals, which they pierce and tear with their sharp rostrum, while they hold them with the forceps of their fore-feet. They fly well, especially in the evening and night, and convey themselves from one pool to another.

The rostrum particularly is inflected; body oval; the antennæ are shorter than the thorax; the hind feet hairy, and fitted for swimming; the four wings fold crosswise, with the anterior part coriaceous; the two fore-feet are cheliform, or resemble the claws of a crab; the other four not elongate, filiform; formed for walking: all three species are found in the water, where they dwell, as do their larvæ and chrysalids: in the water likewise we find the eggs of the water scorpion, of an oblong shape, having at one of their extremities two or more bristles or hairs. The insect sinks its egg into the stalk of some water plant, so that the egg lies concealed, and only the hairs are visible. Those stalks loaded with eggs may be easily preserved in water; and the young water-scorpions, or their larvæ, be hatched under one's own roof.

NOTONECTA, THE BOAT-FLY.

This insect, seen in stagnant waters, swims on its back, and presents its abdomen upwards; hence its Greek name of *Notonecta;* the hinder feet, longer than the rest, serve as paddles. It dives very nimbly when attempted to be caught; after which, it rises again to the surface. It must be cautiously handled, to avoid being pricked by the point of its rostrum, which is exceeding sharp, and the wound intolerably painful, though it goes off in a few minutes. The larva very much resembles the perfect insect. When taken out of the water, it hops. It is very common in the ponds in Hyde Park, and other places about London.

LEPIDOPTERA.

THIS extensive and beautiful class consists of the butterflies and moths: for the British varieties of which, see also Vol. iii. The wings are four, membranaceous, irregularly ribbed, and covered with coloured scales, in the form of a farinaceous powder. The parts of the mouth are formed for suction. There are only vestiges of the labrum and mandibulæ. The maxillæ are produced, with a groove on the inner edge. When united, as they are naturally, they form a tubular proboscis, through which the animal obtains its food. The maxillary palpi are minute, inserted upon the base externally. The labium is short, without joints, and supports two obvious palpi with three joints. There are two compound eyes, and in some species two ocelli. The antennæ consist of many joints, and are usually much longer than the head. The segments of the thorax are united. The tarsal joints are six in number. The larvæ have six feet with claws, and from four to ten others on the posterior portion of the body, which they use as suckers.

Dr. Roget, in his Lecture on the Physiology of Insects, at the Royal Institution in 1823, remarked, that while the *larvæ* of the different tribes differ widely from each other in their structure and mode of life, yet, when they attain the last stage of their growth, they are found to have approximated more or less to a common standard, or type, or organization. Whatever may have been the previous habits of the larva, whether it resided in the waters, burrowed underground, or was lodged in the interior of some vegetable or animal substance, it no sooner emerges from the state of pupa, than it is ushered at once into a new world; its past life appears to vanish; it quits its former haunts, deserts its former associates, and loses all those appetites and instincts which it before possessed. It spreads its pinions to the wind, which bears it onwards to new objects of gratification, and, gaily fluttering from one flower to another, refuses to claim kindred with its brother worm, which yet crawls on the ground.

The *external covering* of the body is of a firmer and denser texture in the perfect insect than in the larva, and gives effectual protection to the softer organs which are inclosed within it. It forms an external skeleton, presenting broad surfaces of attachment to the numerous muscles that move the limbs and the different parts of the trunk upon each other. It is always of a darker colour than in the larva, owing to the addition of a peculiar colouring-matter which has been termed the *pigmentum nigrum.* The body of the insect is divided into several parts or segments, which are connected together by flexible ligaments; and the divisions are sometimes so strongly marked, that the different portions are attached to each other only by slender filaments. This is a character which they possess in common with all articulated animals, and which belongs to the general type of their formation, consisting of a series of rings, or segments joined endwise, in the direction of a common axis.

The principal divisions of the body of *winged insects* are those of the head, thorax, and abdomen. The *head* contains the mouth and the principal organs of the senses. The *thorax* is the general fulcrum of the organs of progressive motion, being that part in which the centre of gravity is situated, and to which both the legs and wings are connected. The *abdomen* contains most of the viscera, or organs of the vital functions, and is composed of several annular joints, the number of which, and their various modes of articulation in the different orders of insects, were described. The pieces which compose each *leg* are arranged under four divisions, namely, the haunch, the thigh, the tibia or shank, and the tarsus or foot, to the extremity of which is generally affixed a double hook, or claw. An account was given of the particular contrivance of cushions on the tarsus of the larger species of grass-hoppers, apparently calculated to lessen the jar which the body would sustain on coming to the ground from a considerable height. The smaller species are not provided with these cushions, probably because the lightness of their bodies secures them against any danger of this kind.

For the purpose of enabling animals *to cling* to objects, and sustain themselves on their under surfaces in opposition to gravity, a still more refined mechanical expedient consists of a circular or oval disc, with flexible membranous edges, capable of being exactly applied to the surface of the body on which it is placed. If any force be applied so as to raise the disc in a direction perpendicular to the plane, these loose edges are brought still closer round the margin by the pressure of the atmosphere, and act the part of valves, preventing any air from insinuating itself between the disc and the solid body. The pressure of the atmosphere thus acts solely on the exterior surface, and is directly opposed to the separation of the two surfaces.

In larger animals, where the size of the organ allows of a more accurate examination of its structure, muscular fibres may be discovered, attached to the membranes, and the actions of which promote the operation of the instrument by rendering the application of the surfaces more perfect, and by securing more effectually the exclusion of air. The mechanism of these suckers may be distinctly seen in the *musca vomitoria*, or blue-bottle fly, by observing with a magnifying lens its movements in the inside of a glass tumbler. The common house-fly has two suckers at the extremity of each of the feet; the *tabanus*, or horse-fly, has three. In the yellow saw-fly the suckers are four in number, one being placed upon the under surface of each of the four first joints of the tarsus.

In some insects, which, like the gnat, walk much upon the surface of the water, the feet are terminated by a brush of fine hairs, the points of which repel the water and prevent the animal from sinking or being wetted. Some species of *podura* are enabled, by means of their broad and flattened tails, to leap from the surface of water with as much ease as if it were a solid resisting plane. The *lepisma* has eight pair of springs, one on the lower part of each abdominal segment, by the sudden unbending of which it leaps to prodigious distances. In the *elater*, or elastic beetle, the legs are so short, that the insect is unable to turn itself when laid upon its back: this deficiency is remedied by the peculiar contrivance of an elastic spine at the back of the thorax, which locks into an adjoining cavity, and recoils with great force when disengaged, throwing up the body to a considerable height, and allowing it to fall upon its legs.

The means by which insects fly are next to be considered. The faculty of transporting the body through so rare a medium as the atmosphere, results only from the highest refinement of mechanism. In order that the body may be propelled, or even sustained in the air, a powerful impulse must be given to the wings, and this impulse must be repeated in very quick succession. Hence the muscles which move these organs are exceedingly vigorous and rapid in their contractions; and the wings themselves are broad expansions of a fine and delicate membrane. The number, form, and structure of the wings have furnished very natural characters for the distinction of insects into orders.

The order of *lepidoptera,* which comprises the innumerable tribes of butterflies and moths, have two pair of wings, of large size, covered with a multitude of minute scales, which, when examined with the microscope, are found to be arranged in the most regular and beautiful order. In the *neuroptera* and *hymenoptera,* all the wings are membranous and transparent; the nervures, or veins, in the former being numerous, and crossing each other nearly at right angles, like the meshes of net-work; and in the latter, being fewer, being joined at oblique angles, and resembling more in their arrangement the distribution of blood-vessels. In the order of *coleoptera,* which includes the whole of the beetle tribes, the lower pair of wings, which are light and transparent membranes, are protected by horny cases, called *elytra,* under which they lie folded up when not in use. These elytra are improperly denominated wings, since they are never employed as instruments of flight. In the *orthoptera* the coverings of the wings, instead of being of a horny texture, are soft and flexible; and the wings themselves, being broader than the elytra, are folded longitudinally, like a fan, when the insect is not flying

In the new order established by Mr. Kirby, under the title of *strepsiptera,* but to which Latreille has given the name of *rhipiptera,* the elytra are long and narrow, and are fixed at the base of the anterior legs, so that they do not appear capable of affording protection to the wings. The wings are very ample, forming, when expanded, the quadrant of a circle, with radiating nervures and folds, as in the orthoptera. In the *hemiptera,* the elytra are in one part coriaceous, and in the other part membranous; and the true wings are folded transversely, so as to cross one another. The order of *diptera* comprises insects which have only a single pair of wings, the halteres, or poisers, appearing to supply the place of the other pair.

In the nutritive functions of perfect insects, the receiving organs, are adapted to the nature of the food, which is often entirely different from that of the larva of the same species. In those insects that live on fluids, an apparatus for suction is provided; where the food is solid, we meet with complex instruments for cutting and grinding. The structure of the stomach and intestinal canal is varied prodigiously, according to the kind of aliment on which their digestive powers are to be exerted. Some insects have a succession of several cavities, corresponding in their office to the stomach; some have muscular gizzards for breaking down mechanically the harder textures of the food; others perform a ruminating process. Honey is the product of a first digestion performed in one of the stomachs of the bee, and is returned in this state into the mouth, to be deposited in the combs as a provision for future consumption; the effective digestion being accomplished in the second stomach of the insect.

Beauty and deformity, says Mrs. Wakefield, are qualities of a very opposite nature; a spider is stamped upon without mercy, because he is ugly; and the tender wing of the butterfly is frequently crushed by the hand of its admirer. Lord Byron, in his "Giaour," has illustrated this effect of beauty in the following lines:—

"As, rising on its purple wing,
The insect green of eastern spring,
O'er emerald meadows of Kashmeer,
Invites the young pursuer near,
And leads him on from flow'r to flow'r,
A weary chase, a wasted hour;
Then leaves him as it soars on high,
With panting heart and tearful eye:
So beauty lures the full-grown child,
With hue as bright, and wing as wild,
A chase of idle hopes and fears,
Begun in folly, clos'd in tears.
If won to equal ills betray'd,
Woe waits the insect and the maid.
A life of pain—the loss of peace,
From infant's play—and man's caprice
The lovely toy, so fiercely sought,
Has lost its charm by being caught;
For ev'ry touch that woo'd its stay,
Has brush'd its brightest hues away.
Till charm, and hue, and beauty, gone,
'Tis left to fly and fall alone.
With wounded wing and bleeding breast,
Ah! where can either victim rest?
Can this, with faded pinion, soar
From rose to tulip, as before?
Or beauty, blighted in an hour,
Find peace within her broken bower?
No; gayer insects fluttering by,
Ne'er droop the wing o'er those that die;
And lovelier things have mercy shown,
To ev'ry failing but their own;
And ev'ry woe a tear may claim,
Except an erring sister's shame."

BUTTERFLIES.

The most remarkable of the foreign species are as follow:

The butterfly named the *Priam*, is one of the most beautiful of the genus of the *Equites Iroes.*

Its extended wings measure more than six inches; the upper wings are of a velvet black, with a broad band of bright grass green, of the lustre of satin, drawn across the upper and lower parts of the wings. On the contrary, the lower wings are of the same green, edged with velvet black, and marked by four spots of the same colour, while at the upper part of each is an orange-coloured spot. The thorax is black, with sprinklings of lucid green in the middle, and the abdomen is of a bright gold colour. It is a rare insect, and is found on the island of Amboyna.

The butterfly *Menelaus* is particularly striking, and is about the same size as the *Priam*, and its colour the most brilliant silver blue that imagination can conceive, changing with the variation of the light, sometimes to a greenish cast: the under part of it is brown, and it is a native of South America.

The Swallow-tailed Butterfly, called *Machaon*, is the only one of the tribe of the *Equites* that our country can boast.

It is of a beautiful yellow, with black spots along the upper edge of the superior wings. A deep edging of black borders all the wings, decorated by a double row of crescent-shaped spots, of which the upper is blue, and the lower yellow: the under wings are tailed, and are marked at the tip with a round, red spot, bordered with blue and black. The caterpillar is a bright green, with bands of a deep glossy purple, enriched with yellow spots. It feeds on fennel, and other umbelliferous plants.

The butterfly, *Apollo of the Heliconii*, is a native of many parts of Europe, but has not yet appeared in our country.

The wings are white, adorned with velvet black spots, and on each of the lower ones are two most beautiful carmine-coloured circles, with a white centre, and black border.

The Betulæ is of a blackish brown, barred with orange colour, and is often found in woods.

The prodigies of showers of blood in ancient history is rationally accounted for by the following circumstance, which was unknown to our ancestors: —the papilionaceous insects, in general, soon after their liberation from the chrysalis, discharge some drops of a red-coloured fluid, which, uniting with the superstition of the times, accounts for the phenomenon.

MOTH TRIBE.

The Sphinx, or Hawk Moth, is so called from the singular attitudes of their caterpillars, which apply the hinder part of their body to a branch of a tree, holding the rest of it erect, like the fabulous sphinx. Most of them spin their cod under ground, making them up with small parcels of earth and grains of corn, interwoven with threads. They fly, either early in the morning, or after sunset in the evening, heavily and slugglishly, often emitting a sound. During one year, in which the inhabitants of Bretagne suffered dreadfully from an epidemic disease, moths of this description were observed in immense numbers. The people, terrified by this singular appearance of their thorax, immediately attributed their sufferings to the visitation of these insects; and the plaintive cry of the insects when taken up tended greatly to confirm this error.

The *Phalæna Atlas* is a native of both the Indies, and its wings frequently measure eight inches from tip to tip; the ground-colour is a rich orange brown, and in the middle of each wing is a large, triangular, transparent spot, bordered with black.

The finest European species is the *Phalæna Junonia*, or Peacock Moth, found in many parts of Germany, Italy, and France.

It is beautifully variegated in different shades of grey, black, and brown; and has on the middle of each wing an eye-shaped spot, the centre black, shaded on one side with blue, surrounded with red brown, and included by a circle of black; an elegant edging of very pale brown encircles all the wings, and the antennæ are finely fringed. The caterpillar from which this beautiful moth proceeds, feeds on the apple and pear trees. Its colour is an apple-green, and each segment of the body is ornamented with a row of upright projections of bright blue, surrounded by long, black filaments, each of which terminates in an elevated tip.

The Silk-worm.—The most valuable moth is the Silk-worm, with whose metamorphosis we ought to be well acquainted. It is found, in a native state, on mulberry-trees, in China and some other eastern countries, whence, in the reign of the Emperor Justinian, it was originally introduced into Europe.

In the East, the silk-worms are left upon the trees, where they are hatched, and on which they form their coccoons. The eggs are of a straw colour, about the size of a pin's head, and their period of hatching is accelerated by heat.

Mr. Bingley, in his *Animal Biography*, gives the following interesting and accurate account of the several stages of the silk-worm :—

At its birth the larva or worm is entirely black, and the length of a small ant ; and it retains this colour eight or nine days. The worms are put on wicker shelves, covered first with paper, and on this with a bed of the most tender of the mulberry-leaves. Several ranges are placed in the same chamber, one above another, about a foot and a half apart. The scaffolding for these ranges should, however, be in the middle of the room, and the shelves not too deep. The worm continues feeding during eight days after its birth, when it becomes about the fourth of an inch in length ; it then experiences a kind of lethargic sleep for three days, during which it casts its skin. It now feeds for about five days, and is considerably increased in size, when a second sickness comes on. In the next ten days it experiences two other attacks ; by which time it has attained its full growth, and is somewhat more than an inch in length, and two lines in thickness. It then feeds, during five days, with a most voracious appetite ; after which, it refuses food, becomes transparent, with a tinge of yellow, and leaves its silky traces on the leaves that it passes over. These signs denote that it is ready to begin the coccoon, in which it is to undergo its change into a chrysalis. The animals are then furnished with little bushes of heath or broom, stuck upright between the shelves : they climb up the twigs, where, after a little while, they begin the foundation of their lodge, and are five days in spinning the coccoon. They generally remain in this state about forty-seven days.

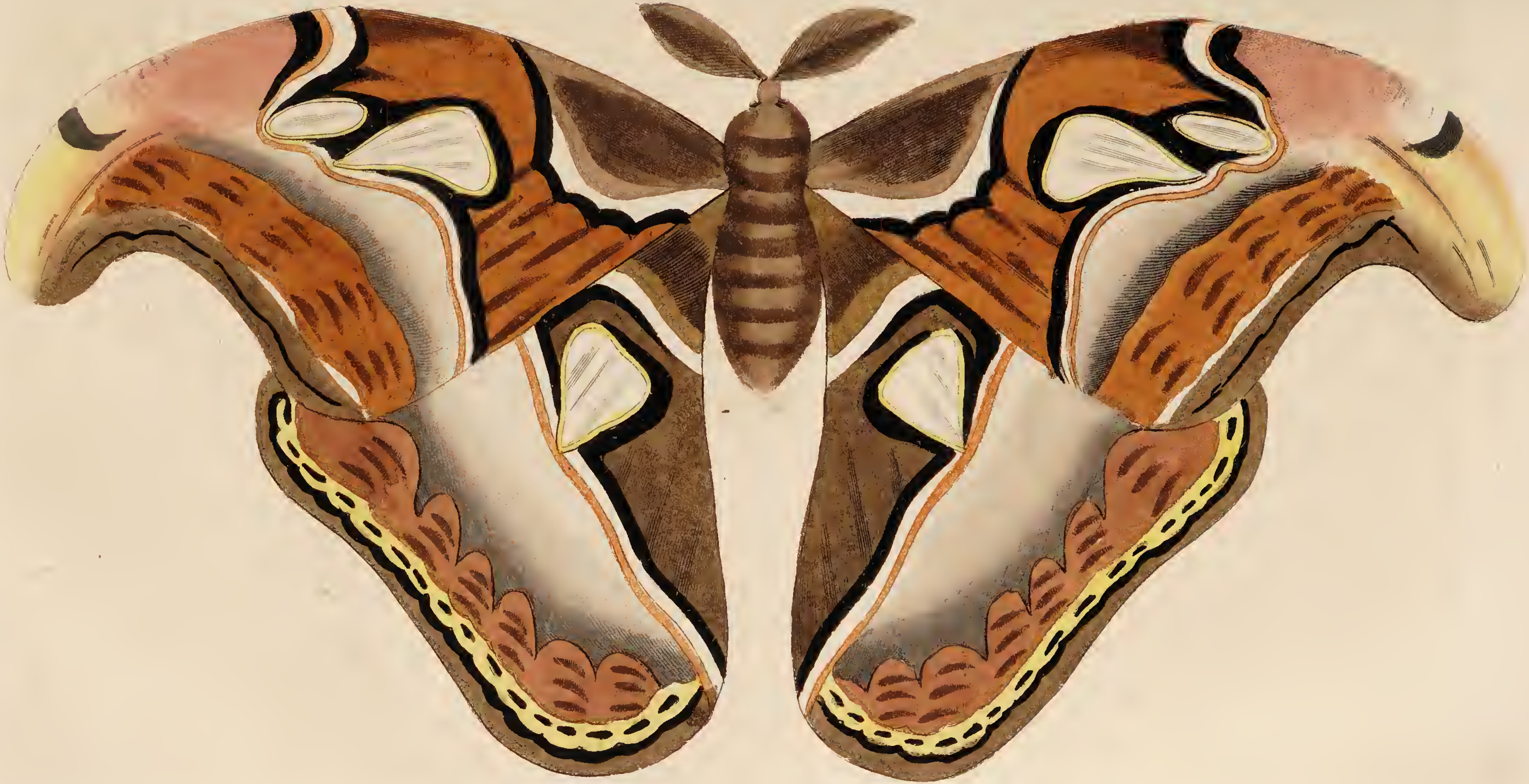
The retreat which they thus form, is a cone or ball of silk, spun from two longish bags, that lie above the intestines, and are filled with a gummy fluid of marigold colour. The apparatus, with which the animal is furnished for spinning the silky threads, that principally compose this bag, resembles, in some measure, a wire-drawer's machine, in which gold or silver threads are drawn to any degree of fineness; and through this the animal draws its thread.

In a state of nature, the silk-worm, previously to the spinning of its web, seeks out some convenient place to erect its cell without obstruction. When it has found a leaf, or a chink fitted to its purpose, it begins to writhe its head in every direction, and fastens its threads on every side to the walls of its retreat. These, being continued, form at length the little oval ball, in which it is to undergo its change.

The exterior of the coccoon is composed of a kind of rough cotton-like substance, called floss; within this the thread is more distinct and even; and next to the body of the aurelia, the apartment seems lined with a substance of the hardness of paper, but of a much stronger consistence. The thread which composes the coccoon, is not rolled regularly round, but lies upon it in a very irregular manner, and winds off first from one side, and then from the other.

Five or six days after the coccoon has been detached, the birth of the moth is prevented, as the insect would otherwise pierce the shell, and thereby render the coccoon useless. To prevent this, the coccoons are put into long, shallow baskets, covered up, and baked for about an hour, in a heat equal to that of an oven, from which the bread is just drawn. After the baking, they are disposed in a proper manner on osier shelves, distributed into stories, two or three feet distant from each other. The whole thread, if measured, will be found about three hundred yards long; and it is so fine, that eight or ten threads are generally rolled off into one. For this purpose the coccoons are put into small coppers or basins of water, each over a small fire. The ends of the threads are found by brushing them over gently with a whisk made for the purpose: and, in the winding, they are each passed through a hole, in an horizontal bar of iron placed at the edge of the basin, which prevents them from becoming entangled.

A fortnight or three weeks generally elapse before the insect within the coccoon is changed into a moth; but no sooner is it completely formed, than, having divested itself of its aurelia skin, it prepares to burst through its prison. For this purpose, it extends its head towards the point of the coccoon, and gnaws a passage through its cell, small at first, but enlarging as the animal increases its efforts for emancipation. The tattered remnants of its aurelia-skin are left in confusion within the coccoon, like a little bundle of



ATLAS MOTH

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Neele & Son 352 Strand

dirty linen. The animal, thus set free, appears exhausted with fatigue, and seems produced for no other purpose than to transmit a future brood. The male dies immediately after its conjunction with the female; and she only survives him, till she has laid her eggs, which are to be hatched into worms in the ensuing spring. The Italians contrive to have two silk-harvests in the year, by keeping the eggs cool; and, when the mulberry-trees (after having been stripped entirely of their leaves for former worms) begin to bud a second time, they expose the eggs to be hatched.

The art of manufacturing silk is said to have been first invented in the island of Cos, by Pamphilis, the daughter of Platis. Silk was first introduced among the Romans, from Serica, where the insect was a native; but so far were they from profiting by the discovery, that they could not be induced to believe so fine a thread to be the work of an insect, and formed so many chimerical conjectures of their own on the subject. Silk was, consequently, a very scarce article among them for many ages, and it was even sold weight for weight with gold; insomuch, that Vopiscus informs us, that the Emperor Aurelian refused his Empress a robe of silk, merely on account of its costliness. Other authorrities, however, assert that it was known in the reign of Tiberius, about A.D. 17. Heliogobalus, who died A.D. 220, is said to have been the first person who wore a garment of silk. The Greeks of the army of Alexander the Great, are said to have been the first who brought wrought silk from Persia to Greece, about 323 years before Christ; but the manufacture of it was first confined to Berytus and Tyre, in Thœnicia, whence it was dispersed over the West. At length, two monks, coming from the Indies to Constantinople, in 555, under the patronage of the Emperor Justinian, brought with them great quantities of silk-worms, with instructions for hatching the eggs, &c.; and hence manufactories were set up at Athens, Thebes, and Corinth. In 1130, a silk manufactory was established in Palermo; and at length the French became acquainted with the management of silk-worms, &c. from their neighbours. In 1455, a company of Silk-women, and the first silk stockings seen in Europe, were sent from Spain to Henry VIII. and Edward VI. James I. was likewise a patron of silk manufactories, and, in 1608, he recommended the people, in a speech from the throne, to plant mulberry-trees for the propagation of silk worms. In 1620, the broad silk-manufacture was first introduced into England; and, in 1629, the silk throwsters of London were incorporated; and, in 1661, this company employed above forty thousand persons.

Several attempts have been made to rear the silk-worm in Great Britain, but all of them have proved unsuccessful. In 1791, a manufacturer of Paisley prepared a web entirely of silk, produced by worms of his own rearing, and several useful experiments with regard to the food and management of these insects are to be found in the Transactions of the Society of Arts.

The cruel practice of pricking the eggs with a needle, to hasten the birth of the worm cannot be too strongly censured; and, when this stratagem is resorted to, the larvæ seldom survive a week. The breeding of these insects has long been a favourite amusement among young persons; and, when we consider the fine sentiments which so exquisite a work of omniscience is calculated to awaken in the minds of youth, the pursuit must be considered as one of no ordinary interest.

Mr. Thomson, during his stay at Calicut, accidentally discovered a species of silk-worm which feeds on the leaves of the wild mango-tree. Among the caterpillars he collected, for the purpose of obtaining butterflies, were some about the size of a man's little finger, with heads and tails of the colour of bright coral, and bodies covered with silvery hairs rising from a black skin. They soon left off feeding and became restless, endeavouring to crawl up the sides of the glass-shade under which they were placed. The motion of their heads from side to side was constant and regular, and Mr. Thomson at length found that they had constructed ladders of most imperceptible threads, and when furnished with dry twigs they began to form their pods. The quality of the silk is coarser than that of Bengal, which may proceed from the nature of their food, as mulberry-trees are not found in that country.

In the valley of Pampanatico, some distance from Lima, there is a caterpillar, called Sustillo; a species of silk-worm, bred upon the pacæ tree, which has the power of weaving a web with the greatest regularity, five feet in length, very remarkable for its lustre and consistency, and subsequently used for paper.

LECTURE XLVI.

NEUROPTERA.

The four wings of this order are membranaceous, transparent, and greatly reticulated by the anastomosing ribs. The under wings are either larger or longer than the upper. The labrum, mandibulæ, maxillæ, and labium, are of the ordinary size, and formed for cutting. There are two large eyes, and two or three ocelli. The segments of the thorax are united, support the six legs, and are distinct from the abdomen.

PHRYGANEA.

This insect, before it becomes an inhabitant of the air, lives under water, lodged in a kind of tube, whose inward texture is silk; outwardly covered with sand, straws, bits of wood, shells, &c. When the hexapod worm is about to become a chrysalis, he stops up the opening of his tube with loose threads, which admit the water, but prevent the approach of voracious insects. The chrysalis is covered within a thin gauze, exhibiting the new form of the insect. The phryganea, on the point of changing its element, rises to the surface of the water, leaves its tube, rises into the air, and enjoys the sweets of the country, fluttering upon flowers and trees, but is soon called away to the water-side to deposit its eggs; whence proceed its posterity. These aquatic larvæ are often found in stagnant waters, where they wrap themselves in the water-lentil, cut into regular squares, and fitted one to another. Trout are very greedy of these larvæ; therefore, in some countries, fishermen after stripping them of their coats, use them for fishing-baits.

There are a variety of different species, but, except the *phryganea bicauda* and *striata*, differing only in size and colour.

The *bicauda* is of a deep dark-brown, with a single yellow longitudinal band across the head and thorax. The legs are brown, also the antennæ, which are long and filiform; two brown threads, almost as long as the antennæ, terminate the abdomen; the wings are about a third longer than the body, veined with brown, narrow at the top, broad below, and seem as if stuck upon the body, which they infold. This insect, met with on the banks of rivers and standing-waters, carries its eggs in a cluster at its abdomen, like some spiders.

The *striata* is a large species, of a dun colour, except the eyes, which are black; much resembles the phalena in the carriage of its wings; the antennæ are as long as the body, and borne forward; the wings are a third larger than the body, with veins of a colour rather deeper; the feet are large, long, and finny.

MYRMELION, OR ANT-EATER TRIBE.

The most remarkable species is the formicarius, or ant-eater.

The perfect insect is oblong, of a brown colour; its head broad, with two large eyes on the sides, and two antennæ beneath; the neck is narrower than the head, rather long and cylindrical; the thorax seems composed of two parts; from the anterior arise the upper wings, and the under ones from the posterior. The wings are diaphanous, adorned with a net-work of black fibres, charged with several blackish brown spots; the abdomen is oblong, and consists of eight segments.

The larva of this insect is very fond of ants, which it hunts after, whence its name. The egg is, by the perfect insect, deposited in very fine dry sand, in a place sheltered from rain, within a cleft of either a wall or the ground, or at the foot of a wall generally exposed to the south sun: there they are hatched, and make their usual abode.

Their colour is grey; and their body, covered with small protuberances, is oval; its posterior extremity terminates in a point, of use to sink down into the sand; for, though furnished with six feet, it walks only retrogressively. Before, the head is a dentated, sharp, and hollow forceps, with which the creature catches and sucks flies and other insects, but especially ants; and serving as an offensive weapon, and also a mouth or rostrum.

This animal's retrograde march preventing its running after the insects on which it is to feed, it uses stratagem: it dives into the sand, and, turning about in a circle, hollows out concentric furrows deeper and deeper, with its horns, casting to a distance the sand. At length it digs a funnel-shaped hole, at the bottom of which it takes its station, concealed; only the open extended forceps appearing above. Mischief overtakes every insect which falls into that hole. The Myrmelion, apprized by the grains of sand rolling to the bottom, with its horns overwhelms the insect with a shower of dust, drags him to the bottom of the hole, then seizes him with its forceps, and sucks the vitals. It does not spare even other myrmelions, who, in their motions, fall into its hole. When the larva is full grown, it digs no more holes; but moves backwards and forwards, tracing irregular furrows on the sand, and at length spins itself a cell, shaped like a ball, the outward part formed of the sand, and the inward lined with fine white silk. Within this it turns to a chrysalis, curved into a semicircle, wherein may be distinguished all the parts of the perfect insect to issue from it. It is more oblong than the larva, but much shorter than the perfect insect. After a certain period, the chrysalis casts off its slough, turns to a winged insect, and breaks through the cell, to take its flight. It is very scarce, but is sometimes met with in sandy places, and near rivulets.

HEMEROBIUS.

This insect takes the name of *hemerobius* from the shortness of its life, which, however, continues several days. In the state of larva it is a great devourer of plant-lice, for which it has had bestowed upon it the appellation of *lion of the plant-lice.* The hemerobii, even after their transformation, preserve their carnivorous inclination. Not satisfied with making war upon the plant-lice, who tamely are devoured, they do not spare each other. The eggs of this insect are borne upon small pedicles, which is a gum spun out by the hemerobius, by raising up the hinder part of its abdomen; and by that means the egg remains fastened to the upper part of the thread. Those eggs are deposited upon leaves, and set in the form of bunches. They have been taken for parasitic plants. The larva, when hatched, finds there its food in the midst of plant-lice. In fifteen or sixteen days, it attains its full growth. With its spinning-wheel at its tail, it makes a small, round, white, silky cod, of a close texture. In summer, at the end of three weeks, the hemerobius issues forth with its wings; but, when the cod has not been spun till autumn, the chrysalis remains in it the whole winter, and does not undergo its final metamorphosis till the ensuing spring.

The mouth is furnished with two teeth; the palpi are four; the wings are deflected, but not plaited; and the antennæ are bristly, and longer than the breast. The species are principally distinguished by their colours.

PANORPA.

The Scorpion Fly is the most common species of this genus.

The rostrum is horny and cylindrical; with two pappi, three stemmata, and feelers longer than the thorax. The body is blackish brown, yellow on the sides, with a few spots on the top; the tail, formed by the three last segments of the abdomen, is maroon; of those three segments, the last is larger, almost round, and terminates in two hooks, as a tail, like the scorpion. The wings, as long as the body, are diaphanous, reticulated, with fibres and stripes of brown spots.

Sometimes we meet with varieties different in the colour of the wings: some, instead of several stripes of spots upon their wings, have only on the middle a single black stripe, transverse and irregular: the extremity also is black: others have their wings white, except the extremity, which is black.

HYMENOPTERA.

The wings are four, membranaceous, and divided into large unequal meshes by the anastomosing ribs; the under wings smallest; the organs of the mouth adapted both for cutting and sucking. For the former operation, the labrum and mandibulæ are sufficiently strong; while the maxillæ are, together with the labium, more or less produced, and, by their union, form a sucker: they have two labial and two maxillary palpi; the eyes are large, and the ocelli three in number; the females are armed with a sting or piercer. Many of the species live in society, and exhibit, in the magnitude and regularity of their operations, the most striking displays of the attributes of the social instinct.

CYNIPS.

The mouth is armed with jaws, without proboscis; the sting is spiral, and mostly concealed within the body. The *quercus folii, or oak-leaf cynips,* is of a burnished shining brown colour; antennæ black; legs and feet of a chesnut brown; and wings white, but void of marginal spots. In the little smooth, round, hard galls, found under the oak leaves, generally fastened to the fibres, this insect is produced, a single one in each gall.

These latter insects are ligneous, of a hard compact substance, formed by the extravasation of the sap, occasioned by the puncture of the gall-fly when depositing its eggs. Sometimes, instead of the cynips, there proceeds from the gall a larger brown insect, which is an ichneumon. He is a parasite, whose mother deposited her eggs in the yet tender gall; which, when hatched, brings forth a larva that destroys the larva of the cynips, and then comes out when it has undergone its metamorphosis and acquired its wings.

The *quercus gemmæ, or oak-bud cynips,* is of a very dark green, slightly gilded; its antennæ and feet are of a dun colour, rather deep. It deposits its eggs in the oak-buds, which produces one of the finest galls, leafed like a rose-bud beginning to blow. When the gall is small, that great quantity of leaves is compressed, and they are set one upon another, like the tiles of a roof. In the centre of the gall there is a kind of ligneous kernel, in the middle of which is a cavity; wherein is the little larva, who feeds there, grows, undergoes its metamorphosis, and breaks through the inclosure of that kind of cod, to get out. The whole gall is often near an inch in diameter, sometimes more when dried and displayed; and it holds to a branch by a pedicle. There are also many other species.

TENTHREDO, THE SAW-FLY.

These insects are not very shy. Some, by means of their saw, deposit in the buds of flowers, others on the twigs of trees or shrubs, eggs, from which are produced caterpillars. The implement with which they are armed, appears only destined to the purpose of depositing their eggs.

The mouth is furnished with jaws, which are horny, arched, dentated within; the right jaw being obtuse at the apex: the lip cylindrical, trifid: there are four feelers, unequal and filiform; the wings are plain and turned; the sting consists of two serrated laminæ, and the scutellum of two grains placed at a distance.

Mr. Marshall, the agriculturist, has collected a number of curious facts relative to that destructive kind of Tenthredo, specifically named *the Turnip-fly*. (See vol. iii.) From the testimony of fishermen who had been long resident on the coast of Norfolk, it appeared that they emigrate in the fly state, in countless millions, from some distant country, probably the north of Europe, across the ocean, being forwarded in their progress by a north-east wind. They arrive in clouds, are supposed to rest occasionally on the surface of the water, and are frequently seen lying in shoals on the beach, in an exhausted condition, from which they are revived by the warmth of the sun.

ICHNEUMONS.

The distinguishing and striking character of these species of flies, is the almost continual agitation of their antennæ. Their name of *Ichneumon* has been applied from their service in destroying caterpillars, plant-lice, and other insects; as the ichneumon, or mangouste, destroys crocodiles.

The mouth is armed with jaws, without tongue; the mandibles and the antennæ have above thirty joints; the abdomen is generally petiolated, joined to the body by a pedicle or stalk; the tail is armed with a sting, enclosed in a double-valved cylindrical sheath; the wings are lanceolated and plain, and laid horizontally on the back. This genus is exceedingly numerous.

The posterior of the female is armed with a wimble, visible in some, yet undiscoverable in others; and that instrument, though so fine, is able to penetrate through mortar and plaster: its structure is more easily seen in the long wimbled fly. The food of the family to be produced by this fly, is the larva of wasps or mason-bees; for it no sooner spies one of those nests, but it fixes on it with its wimble, and bores through the mortar of which it is built. This wimble is of an admirable structure, and consists of three pieces; two collateral ones, hollowed into a gutter, serve as a sheath, and contain a compact, solid, dentated stem, along which runs a groove that conveys the egg from the animal, who supports the wimble with its hinder legs, lest it should break; and, by a variety of movements, dexterously performed, it bores through the building, and deposits one or more eggs, according to the size of the ichneumon, though the largest drop but one or two. Some agglutinate their eggs upon caterpillars; others penetrate through the caterpillar's eggs, though very hard, and deposit their own in the inside. When the larva is hatched, its head is so situated, that it pierces the caterpillar, and penetrates to its very entrails. These larva pump out the nutritious juices of the caterpillar, without attacking the vitals of the creature, who appears healthy, and even sometimes transforms itself to a chrysalis. It is not uncommon to see those caterpillars fixed upon trees, as if they were sitting upon their eggs; and it is afterwards discovered that the larvæ, which were within their bodies, have spun their threads, with which, as with cords, the caterpillars are fastened down, and so perish miserably.

The *ichneumons* performed special service in 1731 and 1732, by multiplying in the same proportion as did the caterpillars; their larva destroyed more than could be effected by human industry. Those larvæ, when on the point of turning into chrysalids, spin a silky cod. It is very surprising and singular to see those cods leap when placed on the table or hand. Plant-lice, the larvæ of the curculiones, and spiders' eggs, are also sometimes the cradle of the ichneumon fly. Carcasses of plant-lice, void of motion, are often found on rose-tree leaves; they are the habitation of a small larva, which, after having eaten up the entrails, destroys the springs and inward economy of the plant-louse, performs its metamorphosis under shelter of the pellicle which enfolds it, contrives itself a small circular outlet, and sallies forth into open air. There are ichneumons in the woods, who dare attack spiders, run them through with their sting, tear them to pieces, and thus avenge the whole nation of flies of so formidable a foe: other females, destitute of wings, deposit their eggs in spiders' nests. The ichneumon of the bedeguar, or sweet-briar sponge, and that of the rose-tree, perhaps deposit their eggs only in those places, because they find there insects on which they feed.

The female ichneumon is furnished with an instrument resembling a whimble, with which she deposits her eggs in the bodies of other insects whilst alive, and generally in those of caterpillars. For this purpose, the female ichneumon selects her proper victim, and pierces its skin with her tube, introducing her eggs beneath the surface. The animal, thus injured, has no means of redress: all its endeavours to escape are in vain. The ichneumon never quits her hold till she has discharged her whole stock; and the vitals of the caterpillar are so little affected, that it frequently survives some time after the young larvæ have fed upon its nutritious juices; and instances have occurred of its transforming into a chrysalis.

Mr. Marsham, an accurate observer of nature, was the first who has recorded the peculiar attention paid by the Ichneumon Manifestator to its young.

"In June, 1787, he observed one of these insects on the top of a post in Kensington Gardens. It moved rapidly, having its antennæ bent in the form of an arch. With a strong vibratory motion in them, it felt about until it came to a hole made by some insect, and into this it thrust them quite to the head. It remained about a minute in this situation, apparently very busy; then, drawing its antennæ out, it came round to the opposite side of the hole, and again thrust them in, and remained nearly the same time. It next proceeded to one side of the hole, and repeated the same operation there. Having now again drawn out its antennæ, it turned about; and, dexterously measuring a proper distance, threw back its abdomen over its head and thorax, and projected the long and delicate tube, as its tail, into the hole. After remaining nearly two minutes in this position, it drew out the tube, turned round, and again applied its antennæ to the hole for nearly the same time as before; and then again inserted its tube. This operation was repeated three times; but Mr. Marsham approaching too near, in order, if possible, to observe with a glass what was passing in the tube, he frightened the insect away.

"About a week afterwards, Mr. M. was in Kensington Gardens, and saw several of these Ichneumons at work. They seemed to pierce the solid wood with their tubes, which they forced in even to half their length, constantly passing them between the hinder thighs, which they closed, in order to keep the tubes straight, when over resistance would otherwise have forced them to bend. On particular attention, it was discovered, that all those which seemed to pierce the solid wood, did it through the centre of a small white speck, resembling mould or mildew. The latter, on minute examination, was found to be fine white sand, delicately closing up a hole made by the *Apis maxillosa*, and where, no doubt, young bees were deposited."

SPHEGES.

See British Insects, vol. iii.

APIS, THE BEE.

For an account of the Bee, the reader is referred to vol. ii.

A species of honey-bee is found in some parts of America, very different in form and manners from the common bee of Europe. Their combs are a series of small bottles of wax, of a dusky brown or blackish colour; and each nearly of the size and shape of a Spanish olive. They hang in clusters, almost like a bunch of grapes, and are so contrived, that each has its aperture, while the bees are at work upon it; but, as soon as it is filled with honey, this aperture is closed, and the bees leave it, to work upon another vessel. Their lodgings are usually in the hollow of an old tree, or in some cavity of a rock. They are sagacious in choosing the most secure retreats, because their honey is so delicious, that it is coveted by many animals; and they have no power of defending themselves, not having stings. The combs are brittle; and the honey is clear and liquid, like rock-water. It is used by the natives rather as a drink with their food, than as honey.

In Clavigero's History of Mexico, is mentioned a species similar to ours, but without the sting. This is the bee of Yucatan and Chiapa, which makes the fine clear honey of Estabentùn, of an aromatic flavour, superior to all other kinds of honey. Another species resembles the winged ant, smaller than the common bee, and without a sting. This is peculiar to warm and temperate climates; it forms nests, in size and shape resembling sugar-loaves, and even sometimes much larger, suspended from rocks or trees, particularly from the oak. These hives are more numerously peopled than those of the common bee. The nymphs are eatable, white and round, like a pearl; the honey is of a greyish colour, but of a fine flavour.

The Circassians are very noted for their culture of bees, and the quantity of mead, busa, and bees-wax, which they annually exchange for salt. The mead of the Abarrines is deleterious, as the honey is extracted from the blossoms of the azulea pontica and rhododendron. The good quality of the honey on Mount Hymettus, is from two species of savory. The bees in Brazil are black, small, and not painful of sting. They are less irritable than those of our country; as myself and companions readily obtained honey whenever we wished, by cutting open the passage; though not seldom is the tree cut down for the sake of the honey, as the bees make their hives in the hollows of trees. The Hindoos imagine that bees sleep every night upon the blossoms of the (nyctanthes) Arabian jessamine; whence the richness of their honey.

Swammerdam opened a hive, and found it to contain 1 female, 33 males, 5635 working bees, 45 eggs, and 150 worms. To accommodate this population, there were 3392 wax-cells, for the use of the working bees; 62 cells, containing bees' bread; and 236 cells, in which honey had been stored. The number of cells 3690, and of the population 5864.

The operations of this interesting tribe, are thus illustrated by Maurice:—

Mark how intensely, while the blazing day
Pours on their glowing hives its fiercest ray,
Yon buzzing tribes pursue their ceaseless toil,
Loaded with all the garden's fragrant spoil;
Dark'ning the air, behold th' unnumbered throng,
In driving swarms, harmonious glide along;
All in strong bonds of social union joined,
One mighty empire, one pervading mind:
No civil discords in that empire rage,
Save when on idle drones dire war they wage;
No tyrant's thundering scourge, nor rattling chain,
Disgrace the regent-mother's gentle reign;
Eternal laws to industry incite,
All, all, to swell the public stores unite.
Oh! would the mighty states, whose thunders hurled
O'er ravaged Europe, awe th' astonished world,
Oh! would they imitate the blameless race,
Whose num'rous hives their names conspicuous grace?
Their vig'rous industry, their loyal zeal,
Their gen'rous ardour for the public weal;
Be firmly bound by one grand social chain,
And bid through earth eternal concord reign!

FORMICA, THE ANT.

All the species of ants are gregarious; and, like the bees, consist of male, female, and neuter. The neuters, exempted from every sexual function, exercise all the other offices necessary for the existence and welfare of the community: they collect supplies of food, explore the country, and seize upon every animal substance, whether living or dead, which they transport to their nest. They construct every part of their dwelling, hatch the eggs, feed and remove the larvæ, as occasion may require, to different situations favourable to their growth and development: both as aggressors and defenders, they fight all the battles of the commonwealth, and provide safety for their weaker and more passive companions: thus acting the part of slaves in these singular republics. Yet, probably, this anomaly of sex is more apparent than real; and, however different in external conformation to the productive females, they essentially belong to the same sex.

Ants seem endowed with more muscular strength than any other insect of their size. Of this we have proofs in their movements, the toil many undergo, the great loads they carry, (often ten or twelve times their own weight,) and their agility in escaping danger. This high irritability is joined with corresponding power of sensation, manifested in their susceptibility to impressions capable of affecting the organs of sense. They quickly perceive all changes of temperature of the atmosphere; and are readily, and disagreeably, affected by moisture. In the perfection of sight they seem nearly on a level with other insects; the males and females are provided with both the composite and simple eyes. The labouring ants are frequently destitute of the latter;* which confirms the suspicion, that the simple eyes are chiefly instrumental in the vision of distant objects.

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* Latreille describes two species, in which he could not discover the least appearance of eyes by a high magnifying power. One, the *Formica cæca*, inhabits the forests of Guiana, which in history is therefore little known; the other, the *Formica contracta*, is met with near Paris. It always conceals itself, during day, under stones or in obscure recesses, where no light can penetrate; and emerges only during night. It is less social than other ants, collecting in groups of about a dozen individuals, and appears far inferior in sagacity to the rest of the tribe.

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Ants possess acute smell, useful in directing them to their food, and also in enabling them to follow, by the scent, the track of their companions. If the end of the finger be passed twice or thrice across the line of their march, so as to brush off the odorous particles with which the ants already may have impregnated the track, those who follow immediately stop on arriving at the place of the experiment, and afterwards direct their course irregularly, till they have passed over it, when they soon find the path, and proceed with the same confidence as before. Latreille, to discover the seat of smell, long suspected to reside in the antennæ, deprived several labouring ants of these organs, and replaced them near their nests. When thus mutilated, they wandered to and fro in all directions, as if delirious, and unconscious whither they were going. Some companions were seen to notice their distress, and, approaching them with apparent compassion, applied their tongues to the wounds of the sufferers, and anointed them with a liquor from their own mouths.

With regard to their food, very erroneous opinions were prevalent, being often supposed to consume corn, and greatly injure plants, by devouring their roots or stems; but they are chiefly carnivorous, preying indiscriminately on all the softer parts, and especially the viscera, of animals. These, indeed, they will often attack when alive, and overpower by dint of numbers; either devouring their victim on the spot, or dragging it a prisoner into the interior of the nest. If, however, the game be too bulky for easy removal, they make a plentiful meal, and exert, like the bee, a power of disgorging a portion, and of imparting it to their companions at home; and they are able to retain at pleasure the nutricious juices unchanged for a considerable time. They with rapidity consume and anatomize the carcass of any small bird or quadruped that falls in their way; and an easy method of obtaining such natural skeletons, is by placing the dead bodies in the vicinity of a populous ant-hill.

In hot climates, where they multiply amazingly, their voracity and boldness increase with their numbers. Bosman states, that, in one night, they will devour a sheep, leaving it a fine skeleton; while a fowl is only the amusement of an hour. They will attack even living animals of considerable size; rats and mice often become their victims. The sugar ants of Grenada cleared every plantation of rats and other vermin, probably by attacking their young. Poultry, or other small stock, were not raised without great difficulty; and the eyes, nose, and other emunctories of dying or dead animals, were instantly covered. They generally attack the most sensible parts, which have the finest cuticle; and, accumulating about the nostrils, destroy the animal by interrupting respiration. Negroes with sores have great difficulty in keeping the ants from assailing them. Their power of destruction keeping pace with their increase, it is not easy to assign limits to either; and their united hosts are often formidable. Prévost states, that an Italian missionary, resident in Congo, was awaked by his negroes, greatly alarmed at the house being invaded by an immense army of ants, rushing in like a torrent; and, before he could rise, had mounted upon his legs. Upon the floor and passages, they formed a stratum of considerable depth: fire only was capable of arresting their progress. Cows have been devoured in their stalls by these daring devastators. Smith reports, that at Cape Corse, the castle was attacked by legions of ants, preceded by thirty or forty, acting as guides: at day-break they made this incursion, entering first by a chapel, on the floor of which some negro servants were lying, who, assailed by this enemy, fled with precipitation, and alarmed their master, who could hardly recover from his astonishment at beholding the advancing multitude, extended a quarter of a mile before him. There was little time for deliberation; and a desperate expedient was adopted of putting a long train of gunpowder across the line of their march, extending it to their flanks, which had already began to deploy, and, setting fire to the whole, millions were destroyed at one blow, which so intimidated the rest, that the whole army retreated in disorder.

Mr. Campbell, in South Africa, observed in the district of Albany, at the Cape, an ant-hill, five feet high, and twelve in circumference; and, in the forests of Guiana, they actually are from fifteen to twenty feet high; and, viewed from a distance on these widely extended savannahs, they resemble the rude huts of savages; but they contain a race more ferocious than the savage, or the tiger himself, and cannot be approached by man without the utmost danger of being devoured. When new settlers, in clearing the country, meet with any of these, they immediately desist from their task, and often abandon the neighbourhood, unless they can speedily destroy this enemy in his citadels, whence he is able to pour forth an overwhelming number of combatants. The only method of accomplishing this, is digging a trench all round the ant-hills, filling it with dry wood, and setting fire to it on every side, by lighting it quickly in different places; thus cutting off all retreat to the ants; then to batter down the edifice. The ants, thus scattered, soon perish.

The cultivation of the sugar-cane in the West-India Islands has often been severely checked by the ravages of ants, by undermining the roots, to establish their nests where they can be protected from heavy rains, and secured against agitation from violent winds; which great advantages, the sugar-cane affords them. No part of the plant constitutes their food; nor do those trees afford them food among whose roots they burrow, and which they speedily destroy, by preventing the access of moisture.

Ripe fruits are often attacked by ants, probably on account of the sugar they contain; and the buds of trees are also often injured by their depredations, as they do not feed upon corn, or other vegetable seed. Honey and sweetmeats have strong attractions for ants, who, if they once discover the way to a magazine of these dainties, will immediately communicate the tidings to all the society, and, leading them to the spot, a regular path will soon be established, which will continue crowded with a train of depredators, as long as any thing remains to be pilfered. Ants, however, do not hoard provision for future consumption. They grow torpid when the cold exceeds 27° of Fahrenheit, and require no food, and the aphis affords them sufficient nourishment at other periods of winter.

In building their nests, each species of ant follows its own peculiar mode of construction, and employs different materials. Many, particularly the smaller species, form them of clay; one set building a regular series of apartments in successive stories, with materials furnished by another set of workers, who are excavating the ground below. The ceilings are supported by small pillars in some parts, and by vertical walls in others; while broad arches are in other places raised, to protect larger spaces, and admit of lengthened passages of communication through a long extent of apartments. These ants proceed in building only when the earth is softened by rain or dew, and the atmosphere sufficiently moist to allow of the materials cohering firmly before they dry. On one occasion, when the ants, under the inspection of Mr. Huber, had discontinued their labours on account of a too dry atmosphere, he got them to renew their operations by sprinkling water upon them with a wet brush, in imitation of a natural shower. They carefully close their habitations at night, to prevent the intrusion of other insects; and a few remain outside, as centinels, to give alarm in case of danger. Some species collect fragments of leaves, bark, or straw, with which they construct more permanent and artificially-constructed nests. Others employ only the fine powder from decayed wood. Some, for greater security, establish themselves under a large stone, or in the crevices of decayed buildings. Several tribes, on the other hand, penetrate the solid substance of wood, which they scoop out into numerous cells, leaving only intermediate partitions of extreme tenuity, just sufficiently strong to enable the whole fabric to support itself; while it crumbles into powder when pressed between the fingers.

Mr. Gleditsh describes shoals of a small black ant in Germany, which formed columns in the air to a vast height, and agitated with a curious intestine motion. A similar flight is mentioned by Acolutle, of Breslaw,) which resembled columns of smoke, and fell on the churches and the tops of the houses, where they could be gathered by handfuls. Rayger gives an account of a large swarm, which passed over Posen, directing its course towards the Danube. The whole town was so strewed that it was impossible to walk without trampling on thirty or forty at every step. And Dorthes, describes their appearance in the *Journal de Physique*, for 1790, at Montpellier, when the shoals moved about in different directions, having a singular intestine motion in each column, and also a general motion of rotation. About sunset they all fell to the ground; and, on examining them, they were found to be the *Formica nigra*.

The swarming of ants is not at all analogous to that of bees; its object seems confined to the propagation of the species, not the result of co-operation of numbers, associated in search of a new habitation, in which an already populous assemblage may establish themselves. The infant colonies consist of very small numbers, perhaps wholly the offspring of a common parent, who has migrated alone, or with few companions. The greater number of impregnated females alighting in the neighbourhood of the nest, are seized by the labourers, who immediately deprive them of their wings, and drag them to the nest, where they keep them prisoners, till they deposit their eggs, when each female is attended by a numerous retinue of labourers, who treat her with the greatest deference, solicitous to anticipate all her wants. Contrary to what happen among bees, many females inhabit the same nest, and live together in the utmost harmony.

The eggs at first, are very small, but considerably enlarge before the larva is excluded; being apparently nourished by absorption: the ants, to whose care they are confided, perpetually licking them with their tongues—a fact, which, however curious, is not solitary in the history of insects. The larva comes forth in a fortnight, in the form of a transparent maggot, with a head and wings, but without external organs of motion. They are in this state fed with a fluid disgorged from their stomachs; and also during their transformation to the state of nympha, and of the perfect insect. These affectionate guardians help them to extricate themselves from the web of the cocoon, to unfold the duplicatures of their wings, and supply them with food, till they are capable of procuring it for themselves. The young ant is exceedingly tender and delicate, easily destroyed by excessive humidity or any considerable variation of temperature; and great care and attention are required to bring it to maturity; the constant business of the ants at home is to convey them to different parts of the nest, where the temperature is suitable; and, whenever danger threatens, they show the utmost solicitude for security.

Very different degrees of sagacity belong to different tribes of ants. Some tribes are peculiarly fond of the honey which exudes from the aphis, convey many of these insects into their own nests, lodge them near the vegetables on which they feed, but keep them prisoners within their habitations, and assign them distinct apartments in their subterranean recesses of their dwellings. Conscious of the future advantages derivable from these insects, they collect their eggs, and superintend their hatching with the same care as that they bestow on those of their own species. The aphis lives in perfect harmony with its keepers, who, so far from molesting, defends them courageously against ants from other nests, who frequently attempt to seize on them. Occasionally the ants lodge them in fortified buildings, distant from the nest, in situations most secure from invasion. Not only the aphis furnishes this kind of provision to the ant, but the kermes and gall insect are occasionally employed for the same purpose; and are found domesticated in ant-nests, at the same time that they contain several species of aphis, from all of which, they collect nutriment; and the whole of this system seems analogous in economy with the use which men make of the cow, and even of the very same insect. Like nations, too, they display equal ferocity in the contentions occasionally exhibited between the inhabitants of neighbouring nests; nature appearing to have instilled, together with the love of social order, the same passions of rivalry, ambition, and revenge, whose influence is deplored among the human species. War, the scourge of man, exerts its desolating power among the tribes of gregarious insects, and checks their otherwise excessive increase. The battles between rival colonies of ants are often of prodigious magnitude; millions of combatants engage with a fury and pertinacity truly astonishing. Their weapons of offence are the jaws, capable of inflicting a deep bite, and of instilling into the wound a highly acrid liquor; and also, in many species, a sting in situation and structure like that of the bee, and likewise containing a venomous juice, possessing acid properties, and, though long supposed by chemists to contain a peculiar acid, denominated the Formic, has been satisfactorily shewn by Fourcroy and Vauquelin to consist of the acetic and malic acids, combined with a portion of acid animal matter, to which it owes its peculiar taste and smell. It is extremely volatile and pungent, and the ant, when irritated, is capable of throwing it out in considerable quantities.

Some of the most daring and courageous species, the *Amazon-ant*, make it the business of their lives to attack the nests of the weaker species, and after a desperate conflict, plunder them of their eggs and larva, which they convey to their own nests. These are hatched and reared by ants of the same species as themselves, considered as auxiliaries to the Amazons, who had at some former period kidnapped them from their parent nest. Thus, a society is formed among different species of insects, to which a parallel exists only in the human race. The Amazons live without labour; by the ants procured by this kind of slave-trade, they are attended, fed, and cherished, and equal care taken of their offspring, as of those of their own species. Perfect order is preserved, and the natural instinct of hostility, which in another condition of the society exists between the two tribes, seems in the auxiliaries completely extinguished by their being educated with the race of their original oppressors.

Ants have numerous enemies among quadrupeds and birds; and some, as the ant-eater, dasypus, and manis, or pangolin, together with the tribe of wood-peckers, devour a very large proportion. The *Formica leonis*, or lion-ant, feeds chiefly on these insects. The bees at the Cape frequently drive the ants from their nests, and take possession themselves. Ants are also infested by lice, so minute as to be invisible without the assistance of a very high magnifying power, but resembling in shape those of the fowl and the dove.

Corrosive sublimate is highly poisonous to them, and myriads of the sugar-ants at Grenada were destroyed by it; and it had the effect of rendering the ants so outrageous that they destroyed each other, as seen by a magnifying-glass, and even, though less distinctly, by the naked eye. This effect was also produced even when they only came in contact with the poison. The whole island, however, was so overrun with ants, that the numbers thus destroyed bore no sensible proportion to the whole; and recourse was had to fire, as more applicable to destruction on a large scale. When wood, burnt to charcoal, without flame, and immediately taken from the fire, was laid in their way, they crowded to it in such numbers as soon to extinguish it, though thousands perished by so doing; therefore, holes were dug at proper distances in a cane-piece, and fire made in each of them; thus, prodigious quantities perished, as those fires, when extinguished, appeared in the shape of mole-hills, from the numbers of dead heaped upon them. But, as none of the females, or young brood, were destroyed by this expedient, the ants soon re-appeared in equal numbers as before; and the island would probably have continued subject to them, had not the great hurricane of 1780, at once cleared all the islands.

A gentleman of Cambridge, says Mr. Bingley, one day remarked an ant dragging along what, with respect to its strength, might be denominated a piece of timber. Others were severally employed, each in its own way. Presently this little creature came to an ascent, where the weight of the wood seemed for a while to overpower him: he did not remain long perplexed with it, for three or four others, observing his dilemma, came behind and pushed it up. As soon, however, as he had got it on level ground, they left it to his care, and went to their own work. The piece he was drawing, happened to be considerably thicker at one end than the other. This soon threw the poor fellow into a fresh difficulty: he unluckily dragged it between two bits of wood. After several fruitless efforts, finding it would not go through, he adopted the only mode that a reasoning being, in similar circumstances, could have taken; he came behind it, pulled it back again, and turned it on its edge; when, running again to the other end, it passed through without difficulty. The same gentleman sitting one day in the garden of his college, he was surprised by remarking a single ant busily employed in some work that caused him to make many journeys to and from the same place. This gentleman traced him to the entrance of the habitation of a community, whence he observed him to take the dead body of an ant in his fangs, and run away with it. He carried it to a certain distance, dropped it, and returned for another, which, by the time of his arrival, was brought to the same hole.

The colour of ants seem to vary with climate and circumstances. Bruce relates, that, in the vicinity of the Red Sea, he observed the ants that were creeping on the mountains of purple porphyry were of the same colour.

Dr. Franklin, believing that these little creatures had some means of communicating their thoughts or desires to one another, tried several experiments with them, all of which tended to confirm his opinion, especially the following: he put a little earthen pot, containing some treacle, into a closet, where a number of ants collected, and devoured the treacle very quickly. But, on observing this, he shook them out, and tied the pot with a string to a nail, which he had fastened into the ceiling; so that it hung down by the string. A single ant, by chance, remained in the pot: this ant ate till it was satisfied; but, when it wanted to get off, it could not, for some time, find a way out. It ran about the bottom of the pot, but in vain; at last, after many attempts, it found the way to the ceiling, by going along the string. After it was come there, it ran to the wall, and thence to the ground. It had scarcely been away half an hour, when a great swarm of ants came out, got up to the ceiling, and crept along the string into the pot, and began to eat again. This they continued to do, until the treacle was devoured; in the mean time one swarm running down the string, and the other up.

Swammerdam informs us, that, notwithstanding the smallness of ants, nothing hinders our preferring them to the largest animals, if we consider either their unwearied diligence, wonderful powers, or inimitable propensity to labour. Their amazing love to their young is even more unparalleled among the larger classes. They not only daily carry them to such places as may afford them food, but if, by accident, they are killed, and even cut into pieces, they will, with the utmost tenderness, carry them away piecemeal in their arms. Who can adduce such an example among the larger animals, which are dignified with the title of *perfect?* Who can find an instance in any other creature, that can come in competition with this?

On this, it is only necessary to observe, that the wisdom of the Creator is so conspicuous in all his works, and such surprising art is discovered in the mechanism of the body of every creature, that it is very difficult, if not impossible, to say, where it is most, and where it is least, to be perceived.

Mr. Cambell, the Missionary, saw numerous ants' nests. In shape, they resemble a baker's oven, and were from two to four feet high. These industrious animals have their enemies, especially a creature about the size of a fox, who, after piercing a hole in the side of the nest, pushes in his tongue, when the unwary ants rush towards it in order to investigate what has happened. The tongue being covered with these insects, he draws it in, and swallows the whole, repeating the process till he had devoured millions. The boors also, when travelling, frequently clear out these nests, and use them as ovens for baking their bread.

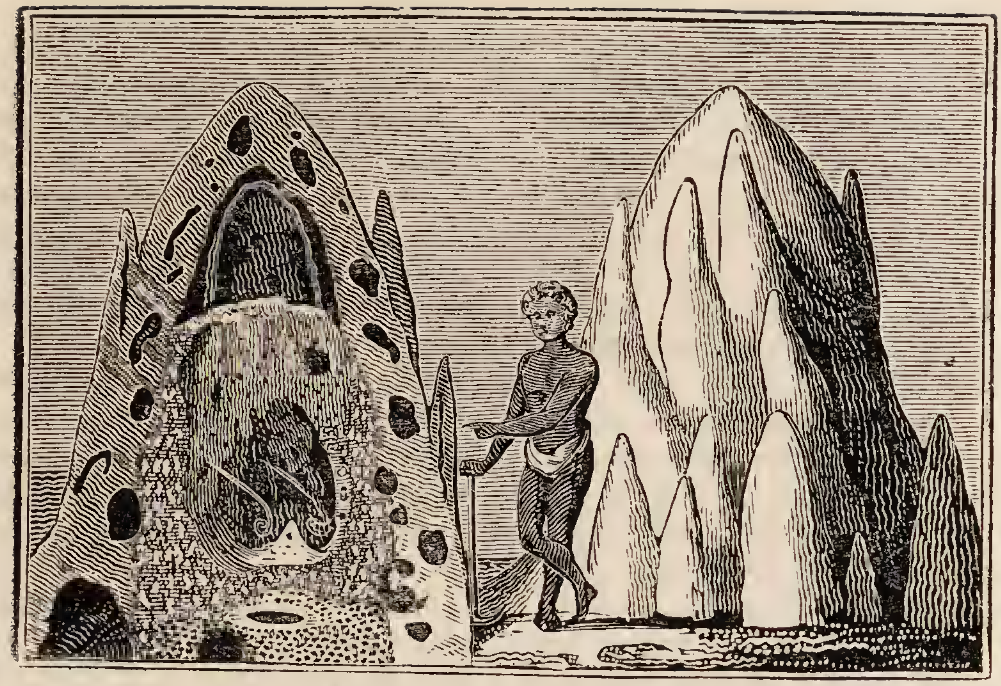
The ant-hills, in the forests of Sweden, are truly wonderful, and so large, that Dr. Clarke could scarcely credit what he saw. They consist of cones formed by the leaves and fibres of pine, and some of them built even to the height of five feet. On examination of them, he could not refrain from observing, that the mansions of these ants, considering the size of the architects, were even more wonderful than the pyramids of Egypt.

As all countries abound in ants, and each of their hills, or nests, contain many thousands, they are, perhaps, the most numerous creatures in existence, and doubtless exceed the human race millions and millions of times; and in general, especially in the British Islands, they are so perfectly harmless, that their ingenuity entitles them to the respect and friendship, as well as the admiration, of man.

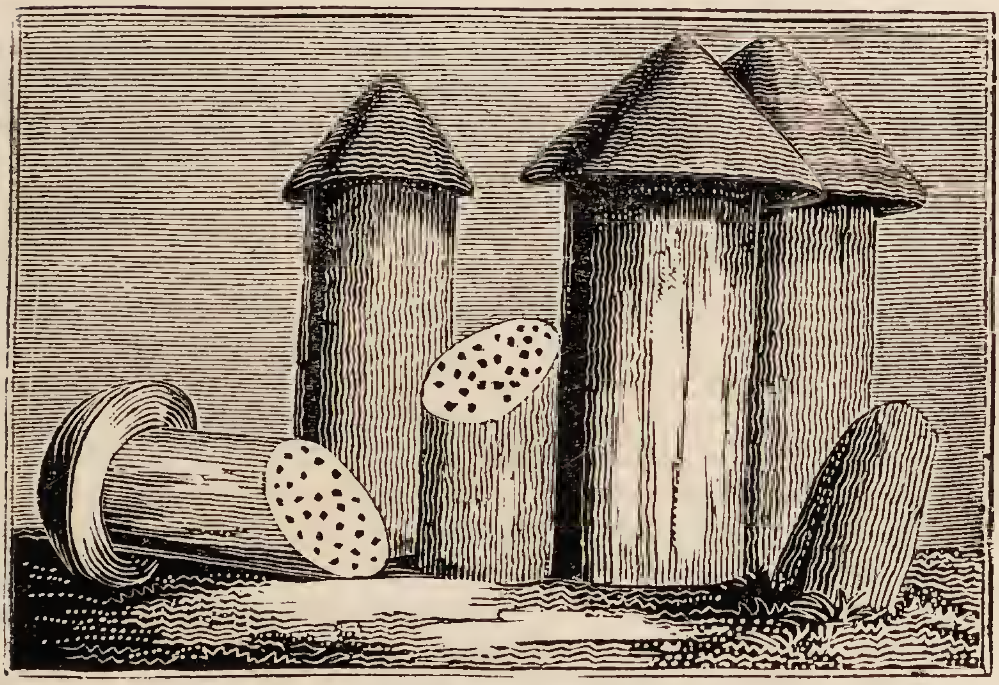
FORMICA LEO, THE ANT-LION,

Is the caterpillar, or worm of a fly, resembling the libellulæ, or dragon-flies; and feeds chiefly upon ants, from which circumstance it derives its name. It is similar to the spider in taking its prey, its manner of spinning, and the figure and softness of its body. Its general figure has some appearance of the millepedes or wood-louse, so as to have been mistaken, at first sight, for that animal. It is of a dirty grey colour, with some black spots, composed of many points when viewed with a microscope, which make it resemble a hedgehog or porcupine. Its body is composed of several rings, hence its wrinkled look. It has six legs; four joined to the breast, and the other two to a longer part, taken for its neck. Its head is small and flat, and it has two remarkable horns, about a sixth part of an inch long, and as thick as a hair, hard, hollow, and hooked at the end, like the claws of a cat. At the origin of each horn, is a clear and bright black eye, which sees very distinctly, and gives the animal notice to escape on sight of the smallest danger.

This creature is not able to hunt its prey, nor to destroy large insects; it can only draw into its snares those which come near its habitation; of these he can manage very few: the winged kind can escape by flight; and the beetle kinds, and others with hard shells upon their bodies, are useless to him, as his horns cannot pierce them. The smallness of the ant, and the want of wings in the neuters, make them the easy prey of this devourer. His manner of catching his prey is as follows:—



The Termites Ant Hills.



The Termites Pyramids.

so necessary to its life, they are restored in case of accidents; for, if cut off, they grow again.

The food this creature procures by its pit, is but little; and not having power of catching its prey any other way, its motion being only backwards, and that slowly, some have supposed that the catching now and then an ant, in this way, was rather for diversion than hunger. But, though the formica leo will live long without food, and even pass through all its changes shut up in a box, yet it always eats when food is offered; it always appears starved and small when so kept; and, if a fly is given it in this hungry state, it will so suck out all its juices, that the remaining shell may be rubbed to powder between the fingers, while the body of the creature that has sucked it appears remarkably swelled and distended; so that the juices of the prey are conveyed into the body of the creature, though it is not easy to see by what means, the horns not appearing to have any perforation.

When the *formica leo* has lived a proper time in this state, it leaves its pit, and is seen only drawing lines and traces on the surface of the sand. After this it buries and encloses itself in a fine web, wherein to pass its transformation into the winged state. This case is made of a sort of silk, which the creature spins in the manner of the spider, and of a quantity of the grains of sand cemented by a glutinous humour from its pores. This case, however, would be too harsh and coarse for the body of the creature, and, therefore, it serves only for the outer covering, to defend it from injuries; the creature spins one within of pure and incomparably fine silk, of a beautiful pearl colour, which covers its whole body.

When the insect has lain some time in this case, it throws off its outer skin, with the eyes, horns, and every other part necesary to life, and becomes an oblong nymph, in which a careful eye may trace the form of the fly into which it is to be transformed. There may be seen, through its transparent covering, new eyes, horns, wings, and all the other parts of the perfect animal. This nymph makes its way about half out of the shell, and remains without farther life or motion, till the perfect fly makes its way out at a slit in the back. In this last state it much resembles the libellulæ or dragon-flies. The male couples with the female in this state only, which is supposed to lay only one egg; but this is very different from other animals of the same class.

When this insect forms its pit in a bed of pure sand, it is made and repaired with great ease; but when it meets with other substances among the sand, the labour becomes more embarrassing. If, for instance, when the creature has half formed its pit, and then comes to a stone of moderate size, it does not desert the work, but goes on, intending to remove that impediment at last. When the pit is finished, the insect crawls backward up the side of the place where the stone is, and, getting its hinder parts under it, takes great pains and time to get it on a true poise, and then begins to crawl backward with it up the edge to the top of the pit, to get it out of the way. It is very common to see a formica leo thus labouring at a stone four times as big as its own body; and, as it can move only backward, and the poise is hard to keep, especially up a slope of such crumbly matter as sand, which moulders away from under its feet, and necessarily alters the position of its body, the stone very frequently falls down when near the verge, and then it is sure to roll to the bottom. In this case the animal attacks it again in the same way, and often is not discouraged by five or six miscarriages; but, after all, attempts again, and at length gets it over the verge of the place. When it has done this, it does not leave it there, lest it should roll in again; but always pushes it farther on, to a necessary distance from the edge of the pit.

The common formica leo moves only backward; but one species moves forward in the common way of other animals, and makes no pit of this kind to entrap its prey, but seizes other insects by force.

The Green Ants, Black Ants, and Red Ants, of New South Wales, are thus described in the expedition under Captain Cook:

Some (says the writer) are as green as a leaf, and live upon trees, where they build their nests of various sizes, between that of a man's head and his fist. These nests are of a very curious structure: they are formed by bending down several of the leaves, each of which is as broad as a man's hand, and gluing the points of them together, so as to form a purse. The viscous matter used for this purpose, is an animal juice, which they elaborate. Their method of first bending down the leaves, we had no opportunity to observe; but we saw thousands uniting all their strength to hold them in this position, while other busy multitudes were employed within, in applying this gluten, that was to prevent their returning back. To satisfy ourselves that the leaves were bent and held down by the effort of these diminutive artificers, we disturbed them in their work; and, as soon as they were driven from their station, the leaves on which they were employed, sprang up with a force much greater than we could have thought them able to conquer by any combination of their strength. But, though we gratified our curiosity at their expence, the injury did not go unrevenged; for thousands immediately threw themselves upon us, and gave us intolerable pain with their stings, especially those which took possession of our necks and hair, from whence they were not easily driven. Their sting was scarcely less painful than that of a bee; but, unless it was repeated, the pain did not last more than a minute.

Another sort are quite black, and their operations and manner of life are not less extraordinary. Their habitations are the inside of the branches of a tree, which they contrive to excavate, by working out the pith almost to the extremity of the slenderest twig; the tree at the same time flourishing, as if it had no such inmate. When we first found the tree, we gathered some of the branches, and were scarcely less astonished than we should have been to find that we had profaned a consecrated grove, where every tree, upon being wounded, gave signs of life; for we were instantly covered with legions of these animals, swarming from every broken bough, and inflicting their stings with incessant violence.

A third kind we found nested in the root of a plant, which grows on the bark of trees in the manner of misletoe, and which they had perforated for that use. This root is commonly as big as a large turnip, and sometimes much bigger: when we cut it, we found it intersected by innumerable winding passages, all filled with these animals, by which, however, the vegetation of the plant did not appear to have suffered any injury. We never cut one of these roots that was not inhabited, though some were not bigger than a hazel-nut. The animals themselves are red, and very small, not more than half as big as the common Red Ant in England. They had stings, but scarcely force enough to make them felt: they had, however, a power of tormenting us in an equal, if not in a greater degree; for, the moment we handled the root, they swarmed from innumerable holes, and, running about those parts of the body that were uncovered, produced a titillation more intolerable than pain, except it is increased to great violence.

MUTILLA.

The species most remarkable is the occidentalis, or *velvet ant*, an inhabitant of North America.

It has six legs, with short crooked antennæ; the abdomen large, with a black list crossing the lower part of it, and another black spot at the joining of the thorax: excepting which, the whole body and head resembles crimson velvet. The trunk, or shell of the body, is of such a strong and hard contexture, that though trod upon by men and cattle, they receive no injury. They have a long sting in their tails, which causes, to those stung, inflammation and great pain for half an hour, and usually happens to negroes and others that go barefooted.

They are mostly sought under the moss, where they conceal themselves, when they find a hollow space beneath it. They are swift in motion, and their wings shine like pearls. But some of them are without wings, which probably marks the distinction of sex. They are said to live together in small communities.

Theber states, that ants chiefly communicate by signs and touch. Fallow ants emigrate very curiously: they are led by a guide, who takes precedence, carrying an ant in his mouth; when a suitable spot is found, both ants return to the nest, when each takes up an ant, and revisits the selected spot; then all four return to the parent nest, and proceed similarly; so that soon the party intent on emigration, remove to the spot directed by the guide. Sufficient remarks have not yet been made to determine whether the black ants of Guiana, and the white ants of Africa, are similar in habits and manners, to those of Europe; but of their destructive powers, several well-authenticated accounts are given; and of these powers we may have a tolerable conception, when Buffon declares, that "no anatomist can strip a skeleton so completely as they; and no animal, however strong, when they have once seized upon it, has power to resist them." They build like an architect, and rule like a citizen, giving the most astonishing proofs of mind; and finely illustrating the greatness and wisdom of that benign Power, whose strength is as conspicuously manifested in the smallest, as in the most gigantic, of his wondrous works.

Ants have parental and filial affections, friendly dispositions, and social sympathies; and when any of the impregnated females die, they lick their bodies for several days, and pay every attention, as if they supposed they could restore life. But, to balance these excellences, they wage war against insects and small quadrupeds; and, like bees, against communities of their own species. The kind called *Amazons*, carry on war, solely to enslave their opponents. They live in nests, with servants of an inferior kind, to perform all the domestic services they require. At certain seasons, they quit their nests in great numbers, in search of those nests which contain the inferior species; a battle ensues, the amazons conquer, plunder the nests of larvæ and eggs, which they convey home, cherish, and, when matured, subject to the performance of all domestic services.

The most remarkable insects seen by Capt. Cook, at New Holland, were the GREEN ANTS. These little animals form their habitations by bending down the leaves of trees, and glueing their ends together like a purse. Though these leaves are as broad as a man's hand, the ants perform this feat by main strength, thousands of them being employed in holding down the leaves, while multitudes of others apply the glutinous matter. Captain Cook's people ascertained this fact, by sometimes disturbing them at their work; when the leaf always sprung up, with an elasticity which the sailors could not have supposed such minute insects were capable of overcoming. For this curiosity, however, they smarted severely; for thousands of these little enemies instantly threw themselves upon the aggressors, and, by their bites or stings, revenged the interruption they had suffered. These were little less painful at first than the sting of a bee; but the pain did not last above a minute.

Another species of ants burrow in the root of a plant which grows on the bark of trees (like the misletoe), commonly as large as a turnip. When this is cut, it appears intersected with innumerable winding passages, filled with these animals; yet the vegetation of the plant suffers no injury. These do not give pain by their stings, but, by crawling about on the skin, produce an intolerable itching. They are about the size of the small red ant. Another sort, which do not molest in any manner, resemble the white ants of the East Indies. They construct nests three or four times as big as a man's head, on the branches of trees; the outsides being composed of some vegetable matter along with a glutinous substance. On breaking the outer crusts of these hives, innumerable cells appear, swarming with inhabitants, in a great variety of winding directions, all communicating. They have also another house built on the ground, generally at the root of a tree; formed like an irregularly sided cone; sometimes more than six feet high, and nearly as much in diameter. The outside of these is of well-tempered clay, about two inches thick; and within are the cells, which have no opening outward. One of these is their summer, and the other their winter, dwelling, communicating by a large avenue leading to the ground, and by a subterraneous passage. The ground structures are proof against wet, which those on the branches are not. In the West Indies there are also flying ants, which make their nests in the small branches of trees, formed of clay and dried vegetables.

The brown ant is particularly remarkable among the masonic tribes. Their nests consist of parallel stories, each a few lines high; the partitions half a line thick, built of fine materials, with the interior perfectly smooth. Each story has chambers of different sizes, with long galleries for communication. The ceilings of the larger are supported by small pillars, or slender walls, or arches. Some cells have only one entrance; others have apertures from the story underneath. Other parts have large central spaces, or halls, where numerous passages terminate, like the streets and avenues to a market place. The whole nest often contains twenty such stories, above the level of the ground, and at least as many below it. Their utility will appear in the sequel. The surface of the nest has a thicker wall or covering, with several doors, admitting in the day-time free ingress and egress. This species of ant being unable to bear much heat, during the day, when the sun shines, their doors are closed; and they either keep at home, or traverse only the subterraneous passages. When the dew gives freshness to the nest, and softens the earthy materials on its surface, they appear above ground; on the first shower, the whole swarm are apprized, and immediately resume their architectural labours. While some remove the earth below, others build an additional story on the top; the masons using the materials furnished by the miners. The cells and partitions are first traced in relief on the walls, and gradually arise, leaving empty spaces between them. The beginnings of pillars indicate the situation of the future halls; and the rising partitions show the form of the intended passages. Upon this plan they continue building, till they reach a sufficient elevation. Then masses of moistened earth are applied on each side, at right angles, to the tops of the walls, and continued horizontally till they meet in the middle. The ceilings of the larger chambers are completed likewise; the workers begin from the angles of the walls, and the tops of the pillars raised in the centre. The largest chambers comparable to the town-hall, and frequently two inches in diameter, is completed as easily as the others. This busy crowd of masons, arriving in every direction, laden with materials for the building, hasten to avail themselves of the rain to carry on their work, yet observing most complete order in their operations, present a most interesting and amusing spectacle. They raise a single story, in seven or eight hours, forming a general roof as a covering to the whole; and add other stories, as long as the rain affords them the facility of moulding the materials. When the rain ceases, and is succeeded by a drying wind, before their work is completed, the earth ceasing to adhere, and crumbling into powder, frustrates their labours; on which, they, with one accord, destroy the cells begun, but not covered in, and distribute the materials over the upper story completed.

In tracing the cells and galleries, each ant follows its own fancy. Hence a want of accordance sometimes occurs at the points where their works join; yet they never are embarrassed thereby. Huber states, that two opposite walls were made of such different elevations, that the ceiling of the one, if continued, would not have been half the height of the other; an experienced ant arriving at the spot, struck with the defect, immediately destroyed the lower ceiling, built up the wall to the proper height, and formed a new ceiling with the materials.

Malouot, in travelling through the forests of Guyana, arrived at a savannah, extending beyond the horizon in a level plain, wherein he beheld a structure that seemed to have been raised by human industry. A traveller who accompanied him, informed him that it was an ant-hill, which they could not approach without imminent danger; they passed some of the paths frequented by the labourers, a very large species of black ants. The nest had the form of a truncated pyramid, from eight to twenty feet high, on a base of thirty to forty feet. When the new settlers, in their attempts to clear the country, meet with one of these fortresses, they either abandon the spot, if not able to muster sufficient force to regularly besiege the enemy, by digging a trench all round the nest, and filling it with dried wood, to which they set fire at the same time in different parts. While the entrenchments are blazing, the edifice is destroyed by firing at it with cannon; and the ants being thus dispersed, have no avenue for escape, and perish in the flames.

A gentleman of the French Academy says, "In a room long empty, was upon a window a box of earth, two feet deep, and fit to grow flowers. It was covered with old plaster, and much rubbish from the top of the house, and the walls, which with the former earth imbued with water, made a dry and barren soil. The place lying southward, and out of the reach of wind and rain, also nigh a granary, was most delightful for ants; hence they had made three nests, doubtless for the same reason that men build cities in fruitful and convenient places, near springs and rivers.

Wishing to cultivate some flowers, I removed a tulip out of the garden into the box; but viewing the ants continually engaged with a thousand cares, unimportant to us, but very important for them, they appeared more worthy of curiosity than all the flowers. I quickly removed the tulip, to be the admirer and restorer of that little commonwealth. This was the only thing they wanted; their policy and social order being more perfect than those of the wisest republics; they have nothing to fear, unless a new legislator should attempt to change their form of government. I procured them all conveniences. I took out of the box every thing troublesome, and frequently visited and studied the actions of my ants. Mostly retiring to bed very late, I went to see them work in a moon-light night: and, frequently in the night, have viewed their labours. I always found some going to and fro, and very busy; one might think they never sleep. Ants come out of their holes in the day, and expose to the sun the corn from their granaries under ground. But these ants brought out their corn only in the night, when the moon shone, and kept it under ground in the day, contrary to what I had seen, and saw still practised, by those insects in other places. I quickly found out the cause; a pigeon-house was near: pigeons and birds would have eaten their corn, had they brought it out in the day-time: probably they knew it by experience; and frequently finding pigeons and birds there, when I went in a morning, I quickly delivered them from those robbers: the birds I frightened away with some pieces of paper tied to the end of a string over the window: the pigeons I drove away several times; and, when they perceived that the place was more frequented than before, they desisted. What is very surprising, (and could scarcely be believed, if not known by experience), those ants knew, some days after, that they had nothing to fear, and began to lay out their corn in the sun: but, not fully convinced of being devoid of danger, they brought not out their provisions all at once, but gradually; first a small quantity, without much order, watching and looking every way, that they might quickly carry it away in case of any misfortune. At last, persuaded that they had nothing to fear, they brought out all their corn, most days, in good order, and carried it in at night.

In every ant's nest is a straight hole, half an inch deep; and, sloping into their magazine, a different place from where they rest and eat. The corn laid up would shoot under ground, did they not prevent it, by biting off all the buds before they store it; yet, though the bud be bitten off, another inconvenience remains; the corn would naturally swell and rot under ground, and be of no use to nourish ants. This inconvenience they obviate by their labour and industry, and so contrive the matter, that corn will keep as dry in their nests as in our granaries.

They gather many small particles of dry earth, bring them every day out, and place them round, to heat in the sun. Every ant brings one particle, lays it by the hole, and then fetches another. Thus, in a quarter of an hour, many such small particles are heaped up round the hole upon that earth. They lay their corn under ground, and cover it with the same: this work is done most days, during the sun's heat; and, though the sun went from the window about four o'clock, they did not remove their corn and the particles of earth, because the ground was very hot, until the heat was over.

Should any one think these animals should use sand or small particles of brick or stone, rather than dry earth ; I answer, upon such an occasion, earth heated in the sun is most proper. Corn does not keep upon sand; and a grain of such corn, being deprived of its bud, would be filled with small sandy particles that could not easily come out.

The ants having brought out those particles of earth, likewise bring out their corn, and place it round the earth. They do this only when the weather is clear, and the sun very hot. Having one day brought out their corn at eleven o'clock, they removed it, contrary to their usual custom, before one; the sun being hot, and the sky clear, I was surprised. But in half an hour, the sky became overcast, and there fell a small rain, which the ants foresaw. These ants fetched their corn out of a garret, where was some old corn, and, as every grain differed, they always chose the best. Those little animals provide themselves with wheat, when they can find it, and always pick out the best; yet they can do without it, and then they take rye, oats, millet, and even crumbs of bread; but barley only, when nothing else can be had. To be particularly informed of their forecast and industry, I put a small heap of wheat in a corner of their room; and to prevent their fetching corn out of the garret, I shut the window, and stopt the holes. Though ants are knowing, they are not conjurors; and therefore they could not guess that I had put some corn in that room. For several days they were much perplexed, and went far to fetch provisions. They were sometimes disappointed, and did not like their corn, after many long and painful excursions. Yet none returned home without bringing something: one a grain of wheat, another a grain of rye or oats, or a particle of earth, if he could get nothing else. I was for some time unwilling to make them more easy, and wished to know whether they would discover the treasure, and see it at a distance; or whether by smelling, they knew what is nutritive for them.

The window, upon which was their settlement, was two stories high, looking into a garden. Some went to the end of the garden, others to the fifth story in quest of some corn; a very hard journey, especially when loaded with a large grain of corn. To bring that grain from the middle of the garden to the nest took up four hours; whence one may judge of the strength and prodigious labour of these little animals. Thence an ant works as hard as a man who should carry on his shoulders a very heavy load, for the space of four leagues, almost every day. It is true, those insects do not take so much pains upon a flat ground; but then how hard for a poor ant to carry a grain of corn up a wall to the second story, climbing with her head downwards, and her body upwards! Only those can have a true notion of it, who see the animals at work in such a situation. Their frequent stops in the most convenient places, plainly indicate their weariness. Some were strangely perplexed, and could not get to their journey's end; in such case, the strongest ants, or those less weary, having carried their corn to the nest, came down again to help them. Some unfortunately fell down with their load, when almost at home. I saw a small one carrying a large grain of wheat with incredible pains; when he came to the box where was the nest, he made so much haste that he fell down with his load, after a very laborious march; such an unlucky accident would have vexed a philosopher. I went down, and found him with the same corn in his paws: he was ready to climb up again. The same misfortune happened thrice Sometimes he fell when half way, and sometimes higher; yet he never let go his hold, and was not discouraged. At last his strength failed, he stopt; and another ant helped him to carry his load, which was one of the largest and finest grains of wheat that an ant can carry. Sometimes, while climbing, a corn slips out of their paws, they take hold of it again, when they can find it; otherwise they find another, or something else, being ashamed to return to their nest without bringing something. This I have observed, by taking away the grain they sought. These experiments may easily be made by one with sufficient patience: much less than that of ants; but few people are capable of it.

Thus were my ants forced to make shift for a livelihood, when I had shut up the garret, out of which they fetched their provisions. At last, sensible that they would be a long time in discovering the small heap of corn, I resolved to shew it them. To know how far their industry could reach, I contrived an expedient with success: (the thing will appear incredible to those who never considered, that all animals of the same kind, which form a society, are more knowing than others.) I threw one of the largest ants upon that small heap of wheat; glad to be at liberty, he ran away to the nest, without carrying off a grain; but he observed it; for, an hour after, all my ants had notice of such a provision, and I saw many very busy in carrying away the corn. Certainly they have a method of communicating their knowledge to each other; else they could not know in two hours after, where there was corn. It was quickly removed, and I put in a small quantity more, to ascertain the extent of their appetite or prodigious avarice; for I consider that they lay up provisions against the winter, as we read in holy Scripture, and a thousand experiments teach us.

The three ants' nests formed three different cities, governed by the same laws, and observing the same order and customs. However, the inhabitants of one seemed more knowing and industrious than their neighbours. The ants were more numerous, larger, stronger, and disposed in better order; their corn was finer; they had a greater plenty of provisions; it was the principal and the capital nest, and those ants were distinguished from, and had some pre-eminence over, the rest. Though the box, wherein the ants had their settlement, was generally free from rain, yet not always; when a certain wind blew this, it was a great inconvenience: ants are afraid of water; and, when abroad in quest of provisions, if surprised by rain, they shelter under something, and do not come out until the rain is over. The ants of the principal nest discovered a wonderful expedient to keep out the rain: there was a small piece of flat slate, which they laid over the hole of their nest in the day-time, when they foresaw it would rain, and almost every night. A number of the strongest surrounded the slate, and in wonderful order drew it equally, removing it in the morning. It was most curious to see those little animals engaged in such a work. Having made the ground uneven about their nest, the slate did not lie flat upon it, but left a free passage underneath. The ants of the other two nests did not so well keep out the rain. Over their holes they laid several pieces of old dry plaster one upon the other; but were still troubled with the rain; and the next day took much pains to repair the damage. Hence those insects so frequently found under tiles, where they settle to avoid the rain. I took care to cover the two nests that were troubled with the rain: but towards the capital nest, there was no need of exercising my charity.

I made a curious experiment, under the same ground. I undertook to make a fourth nest, and went thus about it:—In a corner of a terrace, at some distance from the box, I found a hole swarming with ants, much larger than those already seen but worse provided with corn, and under a bad government. In the box, I made a hole like that of an ant's nest; and laid the foundations of a new city. Then I got a number of ants out of the nest in the terrace, and put them into a bottle, to give them a new habitation in my box; and, afraid they would return to the terrace, I destroyed their old nest with boiling water, to kill those ants that remained. I next filled the new hole with the ants in the bottle; but none would stay. They went away in less than two hours; whence I feared it was impossible to make a fourth settlement in my box. In three days after, going accidentally over the terrace, I was much surprised to see the ant's nest, which I had destroyed, very artfully repaired. I resolved to destroy it entirely, and settle those ants in my box. I put some gunpowder and brimstone into their hole, and sprung a mine, overthrowing the whole nest; and then I carried as many ants as I could get, into the place designed for them. It being very rainy all day and night, they remained in the new hole all that time. Next morning, when the rain was over, most of them went to repair their old habitation; but, finding it impracticable, because of the smell of the powder and brimstone, they returned, and settled in the place appointed for them. They quickly grew acquainted with their neighbours, and who rendered them all manner of assistance outside; but, inside their nest, only themselves were concerned, according to inviolable laws established among those animals.

Were an ant to venture into any other nest but her own, she would be turned out, and severely punished. I have often put an ant of one nest into another, but she quickly came out, pursued by two or three other ants. On trying the same experiment several times with the same ant, the other ants grew impatient, and tore her to pieces. With my fingers, I have often frighted and pursued some ants as far as another hole, stopping all the passages to prevent their going to their own nest. It was very natural for them to fly into the next hole: many a man would be less cautious, and throw himself out of a window, or into a well, when pursued by assassins. But these ants avoided going into any hole but their own, and tried all ways to escape. They fled into another nest, only at the last extremity; and sometimes preferred being taken. It is an inviolable custom to go into only their own hole. They do not exercise hospitality; though very ready to help each other out of their holes, putting down their loads at the entrance of the neighbouring nest, which are carried in by the inhabitants.

They are never attacked by any enemies in a body, as is reported of bees. Their only fear is of birds, which sometimes eat their corn when laid in the sun; but they keep it under ground, when afraid of thieves. They are infested by small worms, but they turn them out and kill them. I observed them punish those ants which probably had neglected their duty; nay, sometimes they killed them. Three or four ants seizing upon one, pulled her until she was torn in pieces. As they generally live very quietly, I infer that they have a very severe discipline to keep such good order; else they are great lovers of peace, if they have no occasion for any discipline.

Was ever greater union in any commonwealth? Every thing is common among them; which is not seen any where else. Bees have each a hole in their hives; their honey is their own; every bee minds her own concerns. The same may be said of all other animals. They frequently fight, to deprive each other of their portion. It is not so with ants: they have nothing of their own; a grain of corn which an ant carries home, is deposited in a common stock; not designed for her own use, but that of the whole community; there is no distinction between a private and a common interest; an ant never works for herself, but for the society. Whatever misfortune happens, their care and industry find out a remedy—nothing discourages them. If you destroy their nests, they will be repaired in two days. Hence the difficulty of driving them out of their habitations without destroying the inhabitants; for, as long as any remain, they will maintain their ground.

LECTURE XLVII.

INSECTS (*continued*).

THE ZIMB.

MR. BRUCE, the traveller, describes the formidable effects of this insect. In appearance, it is weak and contemptible; yet its consequences are more formidable than those of large herds of the most ferocious animals. As soon as this fly appears, the cattle, alarmed by the sound of its buzzing, forsake their food, and run wildly about the plain till they die, worn out with fatigue, alarm, and hunger. The shepherd has no means of securing his flocks from the attacks of this devastating insect, which produces large bosses, swellings, and putrified sores, all over the body of the animal, that prove its certain destruction, but to abandon the rich plains, and hasten with his charge to the sands of Atbara, where his cruel enemy never dares to pursue him.

The prophet Isaiah, continues Mr. Bruce, has given a most striking description of this destructive insect: "And it shall come to pass in that day, that the Lord shall hiss for the fly that is in the uttermost part of the rivers of Egypt; and they shall come, and shall rest all of them in the desolate valleys, and in the holes of the rocks, and upon all thorns, and upon all bushes." Isaiah, chap. vii. ver. 18, 19.—The same writer accounts for the separation of the Israelites and the Egyptians at the time of the plagues; particularly relating to that of the fly inflicted on the latter, by the limits prescribed by circumstances to this insect, that confined it to the black earth of the valley of Egypt, which had been overflowed by the Nile.

The Zimb has no sting, but its motion is more rapid than that of the bee, and resembles the gad-fly in England. Its sound or humming is supposed to proceed from a vibration made with three hairs at the snout.

MUSCA, THE FLY.*—(See Vol. iii.)

THE HESSIAN FLY

Is a very mischievous insect, which a few years ago appeared in North America; and whose depredations threatened then entirely to destroy the crops of wheat.

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* Flies that have been known to remain immersed in strong liquors, even for several months, and afterwards, on being taken out and exposed to the air, have again revived. Dr. Franklin says, some were drowned in Madeira wine, when bottled in Virginia to be sent to England, and at the opening of a bottle of this wine at a friend's house in London, many months afterwards, three drowned flies fell into the first glass that was filled. Having heard it remarked that drowned flies were capable of being revived by the rays of the sun, the Doctor proposed making the experiment. They were therefore exposed to the sun, upon the

It is, in its perfect state, a small winged insect; but the mischief it does is while in the caterpillar state; and the difficulty of destroying it is increased by ignorance, where it deposits its eggs, to be hatched before the first appearance of the caterpillars. These mischievous insects begin their depredations in autumn, as soon as the wheat begins to shoot up, with great voracity. They devour the tender leaf and stem, and continue to do so till stopped by the frost; when this obstacle is removed by the warmth of the spring, the fly appears again, and lays its eggs, it is supposed, upon the stems of wheat just beginning to spire. The caterpillars, hatched from these eggs, perforate the stems of the remaining plants at the joints, and lodge themselves in the hollow, which causes no sign of disease till the ears begin to turn heavy; the stems, then break; and, being unable longer to support and supply the ears with nourishment, the corn perishes about the time it goes into a milky state.

These insects attack also rye, barley, and timothy-grass, though they prefer wheat. The destruction occasioned by them is thus described in the American Museum, for February, 1787. It is well known that all the crops of wheat in all the land over which it has extended, have fallen before it, and that the farmers beyond dread its approach; the prospect is, that, unless means are discovered to prevent its progress, the whole continent will be over-run;—a calamity more to be dreaded than the ravages of war.

This terrible insect appeared first in Long Island during the American war, and was supposed to have been brought from Germany by the Hessians; whence the name of *Hessian-fly*. From thence it proceeded inland at the rate of about fifteen or twenty miles annually; and by the year, 1789, had extended 200 miles from the place where it was first observed; and it continued to proceed with unabating

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sieve which had been employed to strain them from the wine, and in less than three hours two of them, by degrees, began to exhibit signs of life. Some convulsive motions were first observed in the thighs; and at length they raised themselves upon their legs, wiped their eyes with their fore-feet, and, soon afterwards, flew away. Mr. Kirby says, that many flies have recovered, after having been twelve months immersed in home-made wine.

increase; apparently not stopped either by rivers or mountains. In the fly state, it is exceeding troublesome; getting into houses in swarms, falling into provisions, filling the windows, and flying perpetually into the candles. It still infests Long Island, and, in many places, the culture of wheat was abandoned.

The fly at first is white, with long black legs and whiskers, so small and motionless as to be scarcely visible to the naked eye; but they soon become black, and very nimble on the wings and feet, about the size of a small ant. During the height of the brood in June, where fifty or a hundred of the nits have been deposited on one stalk of wheat, some of them sometimes have been seen with the naked eye to twist and move on being disturbed; this is while they are white, when they do not travel from one stalk to another, or to different parts of the same stalk. The usual time of their spring-hatching from the chrysalis is in May. Those who doubt whether the fly is in their neighbourhood, or cannot find their eggs or nits in the wheat, may satisfy themselves at night by opening their windows, and burning a candle in the room. The fly will enter in proportion to the numbers abroad. The first night after the commencement of wheat-harvest, they so filled a dining-room, as to be exceedingly troublesome in the eating and drinking vessels; a glass tumbler, from which beer had been drank at dinner, had 500 flies in it in a few minutes; the windows are filled, when they desire to escape. They are very distinguishable from every other fly by their horns or whiskers.

As great quantities of wheat were formerly imported from America into Britain, it excited the attention of Government how far it was proper to allow such importation, lest this destructive insect might be brought with the grain. The matter, therefore, was canvassed before the privy council; and the substance of the information, caused the importation of American wheat to be at that time forbidden by proclamation.

Its appearance in Long Island, was first observed in 1779; or its destructive effects became then first perceptible; since then it has advanced 15 or 20 miles a year, and neither waters nor mountains have impeded its progress. It was seen crossing the Delaware like a cloud, from the Fall's Township to Makefield; had reached Saratoga, 200 miles from its first appearance, infesting the counties of Middlesex, Somerset, Huntington, Morris, Sussex, the neighbourhood of Philadelphia, all the wheat counties of Connecticut, &c. committing the most dreadful ravages; attacking wheat, rye, barley, and timothy-grass. Those who have suffered, speak of it in terms of horror. Colonel Morgan writing to Sir John Temple says, "Were it to reach Great Britain, it would be the greatest scourge ever experienced; as it multiplies from heat and moisture, and the most intense frosts do not affect the egg or aurelia. Were a single straw, containing the insect, egg, or aurelia, carried and safely deposited in the centre of Norfolk in England, it would multiply in a few years, so as to destroy all the wheat and barley crops of the whole kingdom."

Of all the remedies proposed against this destructive insect, none has been in any degree effectual, except sowing yellow bearded wheat; whose straw is sufficiently strong to resist the impression of the insect, and, even when the eggs are deposited upon it, receives little injury in point of produce.

Mr. Bond mentions another insect in Maryland, called *the fly*, in some respects resembling the Hessian-fly, though not the same. It makes its way into the mow, and bites the ends of the grain perceptibly, and no doubt deposits its eggs in the grain; since wheat recently threshed, and laid in a dry warm place, has been soon covered with an extreme clammy crust, which so binds the wheat on the surface together as to admit its being lifted in lumps; but the wheat beneath will not be hurt to any considerable depth. The quality of this fly is such that if the hand be inserted into the heap infested, watery blisters immediately rise; and farmers and slaves, riding upon bags of this infected wheat, never fail to be severely blistered. This insect was called in Maryland, the *Revolution fly*.

The Musca vermileo, is of a middle-size, of rather a lengthened form, and of a dull yellow, with transparent wings. It inhabits the southern parts of Europe, and forms a circular pit to entrap its prey, in a similar manner to that of the ant-lion.

TABANUS, OR WHAME FLY TRIBE.—(See Vol. iii.)

CULEX, THE GNAT.—(See Vol. iii.)

The Musqueto Fly, is a large variety of the common Gnat, and is found in prodigious numbers in the woody and marshy parts of countries of a high temperature.

It is the female only that bites and sucks the blood; and this operation is so severe, as to swell and blister the skin violently, and even to leave sores. A swelling and itching follow the puncture, and these are succeeded by small white ulcers.

Of all the European nations, *our* Lapland is the most incommoded by the noxious bite of these insects; so that the inhabitants scarcely dare go abroad without first smearing their face with tar and cream. Whilst cutting timber in the woods, they are unable to take the refreshment of their meals; for their mouths, if opened, would be filled with Musquetoes. The animals disappear on a gust of wind, but they return on a calm. They infest the cattle and rein-deer, returning from the woods, which are found covered with Musquetoes; and, on the insects disappearing, their skins are red with blood.

In a cottage in the village of Kollare, in Lapland, the first favour the women conferred on Acesbi and his friends, was to light a fire, and fill the room with smoke. This was done to deliver them from the molestation of the Musquetoes; and, they made a second fire near the entrance of the apartment, to stop the fresh myriads, which would otherwise have swarmed in.

This evil, however, is compensated by some advantage; for the myriads of gnats that swarm in these regions, with their larvæ, that inhabit the lakes, supply nutritious food to the innumerable multitudes of aquatic birds, which, in their turn, are consumed by the natives.

The Musqueto also infests the back settlements of North America, where its pestiferous influence proves a perpetual bane to the social comfort of the settlers. In the West Indies also, it is the chief torment of human life. Indeed no inhabitant of the temperate zones, however much his residence may be annoyed by flies, gnats, or wasps, can have any idea of the annoyance from insects and reptiles of every description, which is suffered between the tropics, where nature teems with life in every various form, and where attack and defence is the universal employment, from the smallest insect to the largest animals.

Numerous accounts of the miseries suffered by man from these causes have appeared in the writings o. voyagers and travellers, but none is more piquant than the following description of these countless myriads, given in Mr. Prior's Voyage, in the 2nd Number of the Journal of Voyages and Travels. In his account of the Mauritius, he says:—

> "The land of Egypt was scarcely more cursed with every species of vermin than our ship. At all seasons, at all hours, and in all places, they attacked us in every possible manner Rats, mice, mosquitoes, locusts, flies, bugs, moths, cockroaches. fleas, scorpions, centipedes, and others, infest the shipping more than the shore, for, having numberless places of concealment in the holds, in the interstices of the beams and timbers, and in the provision casks, it becomes quite impossible to eject the enemy after his having once made a good lodgment. Besides being pestered in the day, we have been frightened in our beds by the prowling of rats, blistered by mosquitoes, bitten by fleas, driven out of bed by bugs, and in danger of being fairly carried off by thousands of cockroaches. The latter, I need not tell you, somewhat resembles your *beetle;* but here they are considerably larger; they fly about confusedly in the night, continually dart on our faces, sometimes extinguish the candles, and lay eggs in which the young in embryo present the same appearance and numbers as the roes of herrings. My cabin is frequently covered by clouds of these creatures, which give it the semblance.of being daubed with animated brown varnish; and my only remedy is a furious assault, right and left, with a weighty towel, which stuns a few of the enemy, and drives the remainder to their covert abodes. Even your familiar acquaintances, flies, acquire here a vigour in their assaults, unknown in Europe. Through the thick covering of a cotton-stocking, I have more than once felt wounds that made me start from my chair. The whole insect and reptile tribes seemed armed against us; raw Europeans make a delicate food, as well as a species of fair game to all of them. Our juices form a perfect living larder to every thing that can either bite or puncture: and I almost look forward with pleasure to the time when I shall be so seasoned, or sun-dried, as to be no longer an article of luxury."

APTERA.

Into this class are placed tribes of insects, which differ greatly from each other in the organs of digestion; but do not agree with any of the preceding classes. They possess one common character in wanting wings, in all the stages of their existence.

The third genus of this order, named *Termes*, is the most interesting, from the curious arrangement of its interior discipline, and the well-contrived structure of the habitations it forms, for the preservation of its young, and the security of its stores.

The Death-watch Termes, is found in decayed furniture, museums, and neglected books; and both the male and female, for the purpose of attracting each other, have the power of making a ticking noise, not unlike that of a watch. Derham was the first naturalist who examined and described this insect. He had often heard the noise, and, in pursuing it, had found nothing but these insects, which he supposed incapable of producing it. One day, however, finding that the noise proceeded from a piece of paper, in his study-window, loosely folded, and lying in a good light, he viewed it through, and perceived a Death-watch Termes in the act of beating. The contemptible superstitions of the vulgar, in connection with the harmless tickings of this insect can serve only for just ridicule.

Termites, the White Ants, are found in the East Indies, and in Africa and South America, where their depredations are greatly dreaded by the inhabitants. Their nests or hills are of such magnitude and so numerous in some parts, as to give the appearance of a group of huts belonging to the natives. These are of a conical form, often rising ten or eleven feet in height. Each community, residing in these hills, consists of three orders, which are different states of the same insect. The first state is that of the labourers, or working insects; they are then about a quarter of an inch long, and are less than our ants; to which they bear some resemblance, and, on that account, have been called *White Ants*. From their fondness for wood, they have likewise been distinguished by the name of *Wood-lice*. In the second state, they assume a different form, and are then called soldiers. Having now no longer any other employment, than that of defending the community from the attack of an enemy, their size is increased nearly double; and the head and mouth, which before were calculated for gnawing, are converted into two jaws, shaped like sharp awls, designed to pierce or cut; for which purpose they are as hard as a crab's claw, and inflict a painful wound.

TERMITES OR WHITE ANTS.

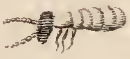

Fig. 1

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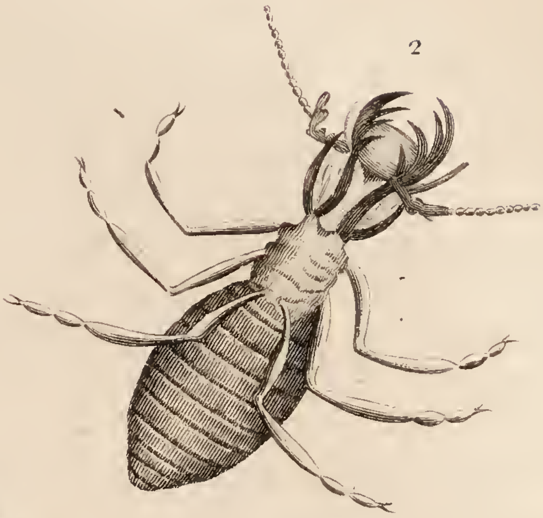

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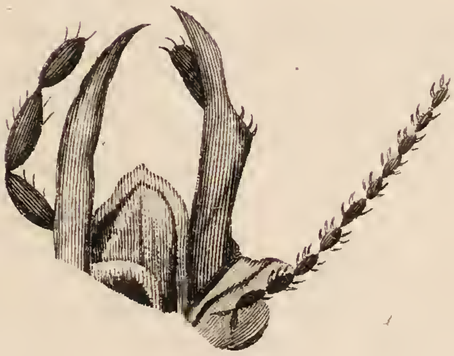

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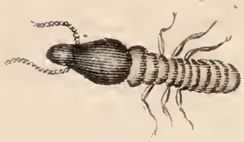

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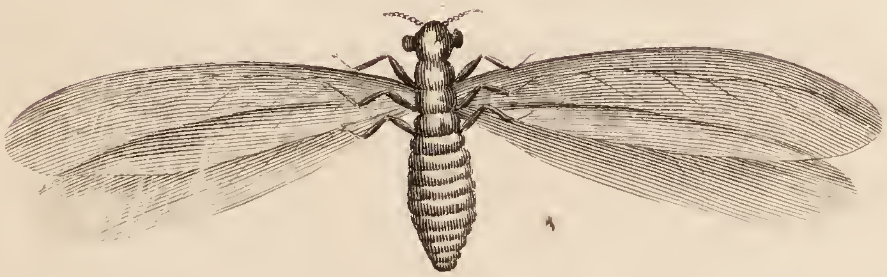

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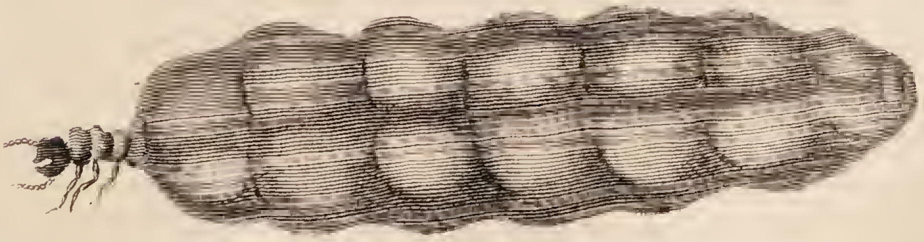


Neele & Son 352 Strand

London, Published by Sir R. Phillips & C°. June 10.1823.

In the next metamorphosis, the head, thorax, and abdomen, differ almost entirely from the same parts in the labourers and soldiers; and four large brown transparent wings are added. This remarkable alteration takes place just before the rainy season begins. They are now changed from one of the most active and fierce animals of their size, to the most helpless and cowardly, having no means of defence. Their numbers, however, are greatly increased.

It often happens, after the first tornado, that the surface of the earth, and even the waters, are covered with them; yet, in a few hours, scarcely one in a thousand is to be found that has not lost one or more of its wings.

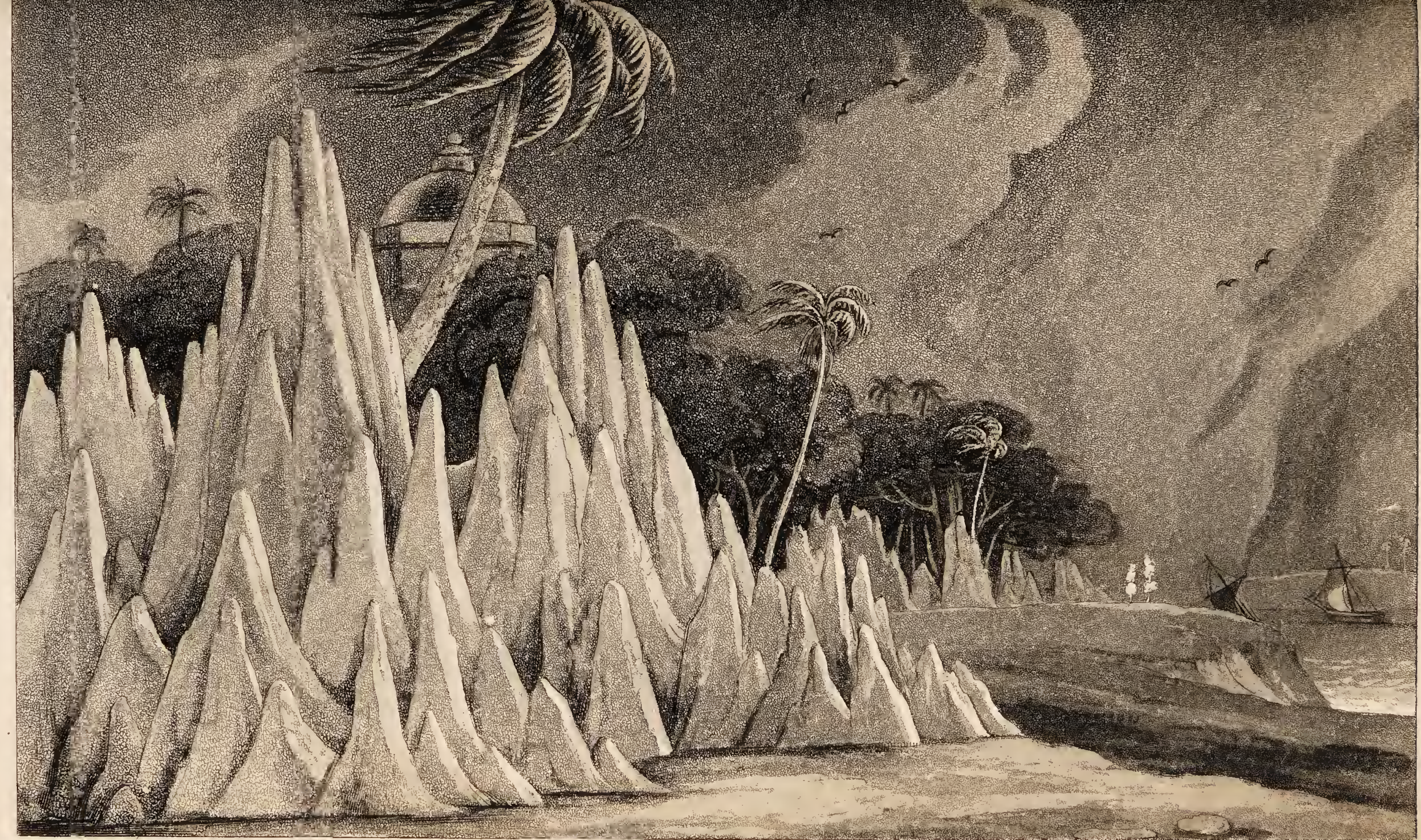
The fortunate pairs who survive this annual massacre and destruction, being casually found by some of the labourers, continually running about on the surface of the ground, are elected kings and queens of new states. Those not so elected and preserved, certainly perish in the course of the following day. By these industrious creatures, the king and queen elect are immediately protected from their innumerable enemies, in a chamber of clay; where propagation soon commences. Their voluntary subjects then construct nurseries entirely of wooden materials, joined with gums. Into these they carry the eggs from the queen as quickly as they can obtain them. Here they form a garden for the cultivation of a species of microscopical mushroom, as food for the young insects.

The queen termes, like the queen bee, is mother of the whole community. After impregnation, a very extraordinary change begins to take place in her person, or rather in her abdomen only. It gradually increases, and at length becomes so enormous, as to be 1500 or 2000 times the bulk of the rest of her body, 1000 times heavier than her consort, and 20,000 or 30,000 times the bulk of a labourer. The matrix has a constant peristaltic or undulating motion, occasioned by the protrusion of 80,000 eggs in twenty-four hours, which are instantly taken from her body by her attendants, (of whom there always are, in the royal chamber and the galleries adjacent, a sufficient number in waiting,) and carried to the nurseries, sometimes four or five feet distant in a straight line; where the young are attended and provided for, until able to provide for themselves, and share the labours of the community.

Each of these hills is composed of an exterior and interior part. The royal chamber is always situated near the centre of the building, and generally on a level with the surface of the ground. The entrances into this chamber not admitting any animal larger than the labourers or soldiers, the king and queen can never possibly get out. The chamber is surrounded by several others, all of them being arched either in a circular or elliptical form. The latter apartments are joined by magazines and nurseries. The magazines are chambers of clay, and are well stored with provisions, which appear to consist of the raspings of wood and plants; but, when examined by the microscope, they are found to consist chiefly of the gums or dried juices of plants. The magazines are intermixed with the nurseries, buildings totally different from the rest of the apartments, which are composed of wooden materials, cemented with gum: they are occupied by the eggs, and by the young ones.

This powerful community commit great devastations, and construct roads, or rather covered ways, in all directions from the nest, to every object of plunder within reach. The mischief they commit, though very great, is probably counterbalanced by the good produced, in quickly destroying dead trees and other substances, which would, by a tedious decay, encumber the ground; their alacrity and dispatch here being such, that the total destruction of deserted towns is so effectually accomplished, as in two or three years a thick wood fills the space, and not the least vestige of a house is discoverable.

Of the police of these insects, we shall mention a singular account, respecting the different functions of the labourers and soldiers, or civil and military establishments, on an attempt to examine their nest or city. On making a breach in any part of the structure, a soldier immediately appears, and walks about the breach, to see whether the enemy is gone, or to examine whence the attack proceeds. He is quickly followed by two or three others; and then a numerous body



W. Daniell in Woods Zeography.

WHITE ANTS HILLS.

rush out as fast as the breach will permit, their numbers increasing while any thing continues to batter the building. During this time, they seem in the most violent bustle and agitation; some beating with their forceps upon the building, making a noise that may be heard three or four feet distant. On ceasing to disturb them, the soldiers retire, and are succeeded by the labourers, who hasten in various directions towards the breach, each with a burden of ready tempered mortar in his mouth. Though there are millions, they never embarrass each other; and a wall gradually fills up the chasm. A soldier attends every 600 or 1000 labourers, seemingly as director of the work; for he never touches the mortar, either to lift or carry it. One, in particular, places himself close to the wall they are repairing, and frequently makes the noise above mentioned; which is constantly answered by a loud hiss from all the labourers within the dome; and, at every such signal, they evidently redouble their pace and exertions. As a renewal of the attack constantly produces the same effects, the pleasure of seeing them come out to fight, or to work, alternately, may be obtained as often as unfeeling curiosity excites or time permits; and certainly the one order never attempts to fight, or the other to work, however great the emergency. The devotion of the soldiers is remarkable: they fight to the very last, disputing every inch of ground so well as often to drive away the negroes, who are without shoes, and make white people bleed plentifully through their stockings.

The strength of these buildings is such, that, when raised little more than half their height, the wild bulls stand as centinels upon them, while the herd ruminate below. When at their full height of ten or twelve feet, the Europeans use them as places to look out from over the top of the grass, which here grows thirteen feet high upon an average.

These ants destroy every substance that can be penetrated by their sharp forceps. They will devour the whole inside of large trees that are beginning to decay; eat through floors; or consume the internal parts of the props of houses, so that the roofs would fall in, were it not for a most extraordinary power that enables them to prevent this ruin to themselves, by filling the cavities they have made with their own mortar; so that the supports of the house, which were wood, become in effect stone. No caution is sufficient, in hot climates, against their depredations.

Mr. Forbes, in his Oriental Memoirs, says, "I could mention many curious instances of depredation by the termites; one happened to myself. I left Anjengo in the rainy season, to pass a few weeks with the chief at Eddova. On my departure, I locked up a room, containing books, drawings, and a few valuables: as I took the key with me, the servant could not enter to clean the furniture. The walls of the room were white-washed, adorned with prints and drawings, in English frames and glasses. Returning home in the evening, and taking a cursory view of my cottage by candle-light, I found every thing apparently in the same order as I left it; but, on a nearer inspection the next morning, I observed a number of advanced works, in various directions, towards my pictures. The glasses appeared to be uncommonly dull, and the frames covered with dust: on attempting to wipe it off, I was astonished to find the glasses fixed to the wall,—not suspended in frames as I left them, but completely surrounded by an incrustation cemented by the white ants; who had actually eat up the deal frames and back-boards, and the greater part of the paper, and left the glasses upheld by the incrustation, or covered way, which they had formed during their depredation. From the flat Dutch bottles, on which the drawers and boxes were placed, not having been wiped during my absence, the ants had ascended the bottles by means of the dust, eat through the bottom of a chest, and made some progress in perforating the books and linen. The chief's lady, with whom I had been staying at Eddova, on returning to her apartments in the fort, found, from the same cause, a large chest, in which she had deposited shawls, muslins, and other articles, collected preparatory to her leaving India, entirely destroyed by these voracious insects."

PULEX, OR FLEA.

The Penetrating Flea, or *Chigoe*, is a kind of small sand-flea, common in Surinam, which gets in between the skin and the flesh without its being felt, and generally under the nails of the toes; where, while it feeds, it keeps growing till it becomes of the size of a large pea, causing no further pain than a disagreeable itching. In time, its operation appears in the form of a small bladder, in which are deposited thousands of eggs or nits, and which, if it breaks, produces so many young chigoes, that create running ulcers, which are often of very dangerous consequence to the patient; so much so, indeed, that the soles of a soldier's feet were obliged to be cut away before he could recover; and some men have lost their limbs by amputation,—nay, even their lives,—by having neglected, in time, to root out these vermin. The moment, therefore, that a redness and itching, more than usual, are perceived, it is time to extract the chigoe that occasions them.

Pulex Arboreus.—These are a kind of half-winged creatures; have granulated antennæ; and some of them, in their most perfect state, have complete wings: hence they are distinguished from the others by the name of *musca pulex*, or the *winged pulex*.

The several species are brown or yellow, but mostly green. They all feed upon the leaves of trees, which become withered or curled up on their fixing upon them; and themselves are so common, that, wherever a leaf is found curled up, or of a different form from the others, it is highly probable these animals are on it, or that it is their work. Among trees, the willow and rose are most infected by them; and, among plants, the bean and the poppy. They live a social life, multitudes of males and females together. The females are easily distinguished from the males, being thicker in the body, and having larger bellies.

Of all known winged animals, only these are viviparous. This is easily seen beyond a possibility of doubt; for, on examining a cluster, it is a common thing to see, by the help of a small magnifier, a female in the act of parturition, and the young pulex protruded, perfectly formed.

Armed with a tender and flexile proboscis, they seize the young shoots of the tree they live upon, twisting the proboscis round it. They are always naked and exposed on the outside of the stalks and leaves, with their proboscis sucking juices for nourishment. But another species, alike viviparous, agree with them in all respects except in manner of living: these get into the inner substance of the leaves, (like the worms called ascarides, (and feed on the parenchyma, being defended from all injuries by living between the integuments. The leaves they bury themselves in become scabrous and deformed, and produce a sort of galls. A female of this species has been seen to bring forth seven young ones in a day; and thus, from residing alone in the tubercles she had formed on a leaf, she soon becomes the mother of a numerous family; each of which raises its own tumor or galls on the leaf, at first small and round, and of a beautiful red like kermes.

The males have a certain time of rest, in which they lie buried in a silky matter, and afterwards become winged, flying nimbly about; whereas the females never are able to fly, but remain always half-winged. There is, however, a different species of winged insects frequently found flying about the female pulices, as well as their own males; so that all the small-winged insects about them are not of their own species. These do not greatly differ in figure; but the one are harmless, and the others have stings, and hurt any part of the body on which they fix.

ACARUS, THE MITE, OR TICK.

Most of the insects of this genus are very minute; but some are of considerable size, particularly the tick, which is frequently seen on dogs, and occasionally on cattle, where they adhere closely to the skin. Two kinds annoy the black beetle: *acarus vegetans* confines itself to the limbs or wing-shells of the beetle, to which it is fixed by a tail, resembling a footstalk, whence it has derived its name.

MITES.—*Gammasus (Coleoptratorum,)* has the body depressed, the skin of the back coriaceous, of a fiscous colour; the anterior legs are the longest. It inhabits the excrements of horses and oxen; and great numbers frequently attach to scarabæi, histeres, &c. —near one hundred having been counted on the common dor beetles. It is extremely minute; its head very small, neck scarce visible; and it has a whiteness about the anus. It runs very swiftly; it infects many insects, as the louse does others: the humble bee, and many other of the larger insects, are continually infested with it, but none so much as the common black-beetle, thence called the lousy beetle.

Oribita (Geniculata,) inhabits trees and beneath stones, and is common in Sweden, Germany, and England. The body is covered with a coriaceous skin, fuscous, shining, and hairy.

Notaspis (Humeralis,) is common on the south of Devon, inhabiting moss, and beneath stones; the body is covered by a coriaceous skin, the produced part membranaceous, inclosing the organs of mastication; the abdomen blackish chesnut, the sides anteriorly with a wing-like process.

Acarus Domesticus, (cheese Mite.) On the coasts of New Guinea are seen, for many leagues a vast profusion of minute substances, during the night. They are also witnessed on the coasts of New Holland; where they are mostly of a greyish colour. In some seas they are red; (hence the fables relative to *seas of blood*, with which the world has occasionally been amused.) Sailors call this collection sea saw-dust. On the Australasian coast, Peron discovered, during a squall, a broad belt of phosphoric light floating upon the water, which was caused by innumerable animals, swimming at different depths, belonging to a new genus of Mollusca, by Peron named Pyrosoma.

Acarus siro, the cheese mite, (see page 90 of this volume.)

Hydrachna, the water mite, consists of small insects, the largest not exceeding the size of a pea, of a flat globular shape, and inhabiting stagnant waters.

Hydrachna geographica, so called from the assimilation of its variations to the lines of a map, is an elegant insect. It is globe-shaped, of a polished black, beautifully marked and spotted with carmine, and the legs curiously fringed with hairs. The hydrachnæ lay their eggs in flat clusters; and sometimes choose for that purpose the bodies of Nepæ, and other water insects.

ARANEA, THE SPIDER.

The treach'rous spider, when her nets are spread,
   Deep ambush'd in her silent den does lie,
And feels, far off, the trembling of her thread,
   Whose filmy cord should bind the struggling fly:
Then, if at last she find him fast beset,
   She issues forth, and runs along her loom
She joys to touch the captive in her net,
   And drags the little wretch in triumph home.—DRYDEN.

These insects, which are remarkable for their industry and mode of life, prey on other insects, and in some cases on their own species. Their bite is venomous; by which means many flies die in convulsions. They have short horny jaws, and two incurved, jointed, and sharp feelers. They are destitute of antennæ; and have eight, or sometimes only six eyes, and eight legs. Their abdomen is hairy, and furnished with papillæ, from which they spin their webs. They frequently change their skins. The larvæ and pupæ have each eight legs, and differ in no respect from the perfect insect.

D'Azara states that spiders, which are solitary in Europe and Asia, live in congregated societies of many thousands on the banks of the Amazon. They take possession of a tree, and unite in forming over it a complete net; then they take their several stations; each labours for itself, secures its own prey without disturbance; but, when any damage is done to the net, all unite in the labour of repairing it for the general good. Is it not a remarkable fact, that the house and garden spiders of Europe are unknown in Ireland, and yet are found in the Loochoo Islands? Spiders are known to be capable of hearing, and not insensible to the charms of music.

The House-Spider.—This unsightly and persecuted, though harmless and curious, insect feeds principally on flies; and forms its curious web to entangle other insects for their food. In making this wonderful web, which seems to have furnished to man the idea of a fishing and fowling net, they are supplied with a quantity of glutinous matter in a receptacle near the extremity of their bodies; and, for spinning it into thread, they have five teats. They first fix on an advantageous spot: the animal then distils a drop of glutinous liquor, creeping along the wall, and ingeniously joining its thread as it proceeds; it then darts to the opposite side, where the other end is to be fastened. This being done, the spider runs on it, still doubling and strengthening it. This scaffolding being completed, the clammy substance binds them to each other. At the bottom of the web is a kind of funnel, which serves as a hiding-place for the little creature, where it lies in wait till its prey is caught; when, like the fowler, it instantly darts upon its unfortunate victim.

The webs of spiders differ from those woven by any human artist in this circumstance: in our work, the threads extended in length are interlaced with those that are carried on transversely; whereas the threads of a spider's woof only cross the threads of the warp, and are glued to them in the points where they mutually touch, and are not either inserted or interwoven. It is a vulgar error that the common house-spider is in any degree poisonous.

When the garden-spider *(Araneæ horticola)* wishes to change her residence, she fixes one end of a thread where she stands, and then draws out several other threads, which, being lengthened out, and driven by the wind, are, by their natural clamminess, fixed to some neighbouring tree or other object. When these are fast, they make a bridge, on which she can pass or repass at pleasure. She next renders the thread thicker, by spinning others to it. From this thread she often descends, by spinning downward, to the ground. The latter thread she fixes to some stone, plant, or other substance. She re-ascends to the first thread, and, at a little distance from the second, begins and fixes a third likewise. She then strengthens the three threads, and, beginning at one corner, weaves across, and forms a strong and durable net; placing herself in the centre, with her head downwards, to wait for her prey.

The Aranea diadema is of a deep chesnut colour, and the abdomen is beautifully marked with round white spots. This spider forms a thick web of yellow silk, in which it deposits its eggs. At the tip of the abdomen are five papillæ or teats, each of which is said to have a thousand openings, through which issues the substance that forms its threads; so that every thread consists of a multitude of finer ones. Its fangs are strong, curved, sharp-pointed, and furnished near the end with an oblong hole, through which it discharges a poisonous fluid into the wound it inflicts.

The Gossamer Spider (Aranea obtextrix).—M. Bechstein, a German naturalist, has given the following interesting account of this industrious insect:

"Some naturalists (says this gentleman,) have considered the gossamer as the evaporation of plants, condensed by the air during the cool days of harvest, and converted into threads like those which can be drawn from resinous juices: others, as the production of a kind of spider, on account of its similarity to the threads of common spiders; and M. Pereboon has discovered a kind of beetle, furnished with a vesicle on its back; from the hinder parts of which, on both sides, proceed two threads, that extend over the extremity of the body, and end in a double thread, sometimes ten or more inches in length: this thread he supposes to form the gossamer.

"Having for many years made the closest observations on this phenomenon, I am of opinion it is caused by a species of field-spider, so small and active as to be imperceptible, unless the observer possess a very acute sight. This spider, if it have no name already, I propose to call the gossamer spider, *aranea obtextrix.* It is about the size of the head of a small pin. Its head is somewhat long, and has in the fore-part eight grey eyes, placed in a circular form. The body is of a shining dark brown colour, with the abdomen shaped like an egg. The legs are yellowish.

"The gossamer spider does not weave a web, but only extends its thread from one place to another. These threads are so delicate, that a single filament cannot be seen unless the sun shines on it. One of them, to be visible at other times, must be composed of at least six common threads twisted together. In serene calm days, these spiders work with great diligence, especially after the disappearance of the morning fogs. Between twelve and two, however, their industry excites the greatest admiration. A person with a quick eye, or by the help of a glass, may sometimes perceive among the barley-stubble such a multitude of these insects extending their threads, that the fields appear as if covered with swarms of gnats.—The gossamer spiders appear in swarms only during the harvest; but single spiders are to be found through the whole summer."

M. de Vaillant concluded that spiders must often remain long without food, and that they were capable of enduring considerable abstinence. To ascertain this, he took a large garden-spider, whose belly was about the size of a nut, enclosed it under a glass bell, which he made air-tight, and left it in this situation for ten months, without food. The insect, however, appeared during the whole time equally vigorous; but its belly at last decreased to the size of a pin's head. He then put under the bell to it another spider, of the same species. At first they kept at a respectful distance from each other, and remained motionless; but the meagre one soon attacked the stranger. In the different conflicts, it deprived the stranger of almost all its claws, which it devoured. The meagre spider, having likewise lost three of its own claws, fed on them also. On the next day, the invader fell a complete sacrifice, and was speedily devoured. Thus, in less than twenty-four hours, the old inhabitant of the bell became as plump as it was at the first moment of its confinement.

M. Bon, an ingenious Frenchman, attempted to establish a manufacture of spider's silk; but it was at length found impracticable, as it required *twenty-*

eight thousand cods to make one pound of silk; and, as none but the females spin these cods, it was necessary to breed a much greater number of spiders.* It was impossible to prevent their preying upon each other, though they were provided with suitable food.† M. Bon, however, obtained two or three pair of stockings and gloves of this silk, which were of an elegant grey colour. Had this project succeeded, there would have been grey, white, sky-blue, coffee colour, and several other new genuine colours in silk.

Lycosa (Tarantula).—The body is depressed, thorax broad, reniform, or luvate; has the breast and belly of an ash-colour, and the legs with blackish rings on the under part; the fangs or nippers are red on the inner side, the outer blackish. Two eyes are large, red, and in front; four others are placed transversely towards the mouth; the other two are nearer the back. It has two antennæ, or feelers. It is a native of Italy, Cyprus, Barbary, and the East Indies; lives in bare fields, and its dwelling is about four inches deep, half an inch wide, closed at the mouth with a net, and curved at the bottom, where the animal sits in wet weather, and cuts its way out if water gains upon it. They do not live quite a year: in July they shed their skin, and proceed to propagation; which, from a mutual distrust, as they frequently devour each other, is undertaken with great circumspection. They lay above 700 eggs, which hatch in the spring; but the parent expires early in the winter, nor lives to see her progeny. The ichneumon wasp is their most formidable enemy.

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* Spiders furnish much less silk than the worms: the largest bags of the latter weigh four grains, the smallest three grains; so that 2,304 worms produce a pound of silk. The work of twelve spiders only equals that of one silk-worm, and a pound of silk will require at least 27,648 spiders. But, as the bags are wholly the work of female spiders, who spin them to deposit their eggs in, there must be kept 52,296 spiders to yield a pound of silk. The large ones seen in gardens only yield a twelfth part of the silk of the others: thus, 280 of these would not yield more than one silk-worm, and 663,552 would scarcely yield a pound.

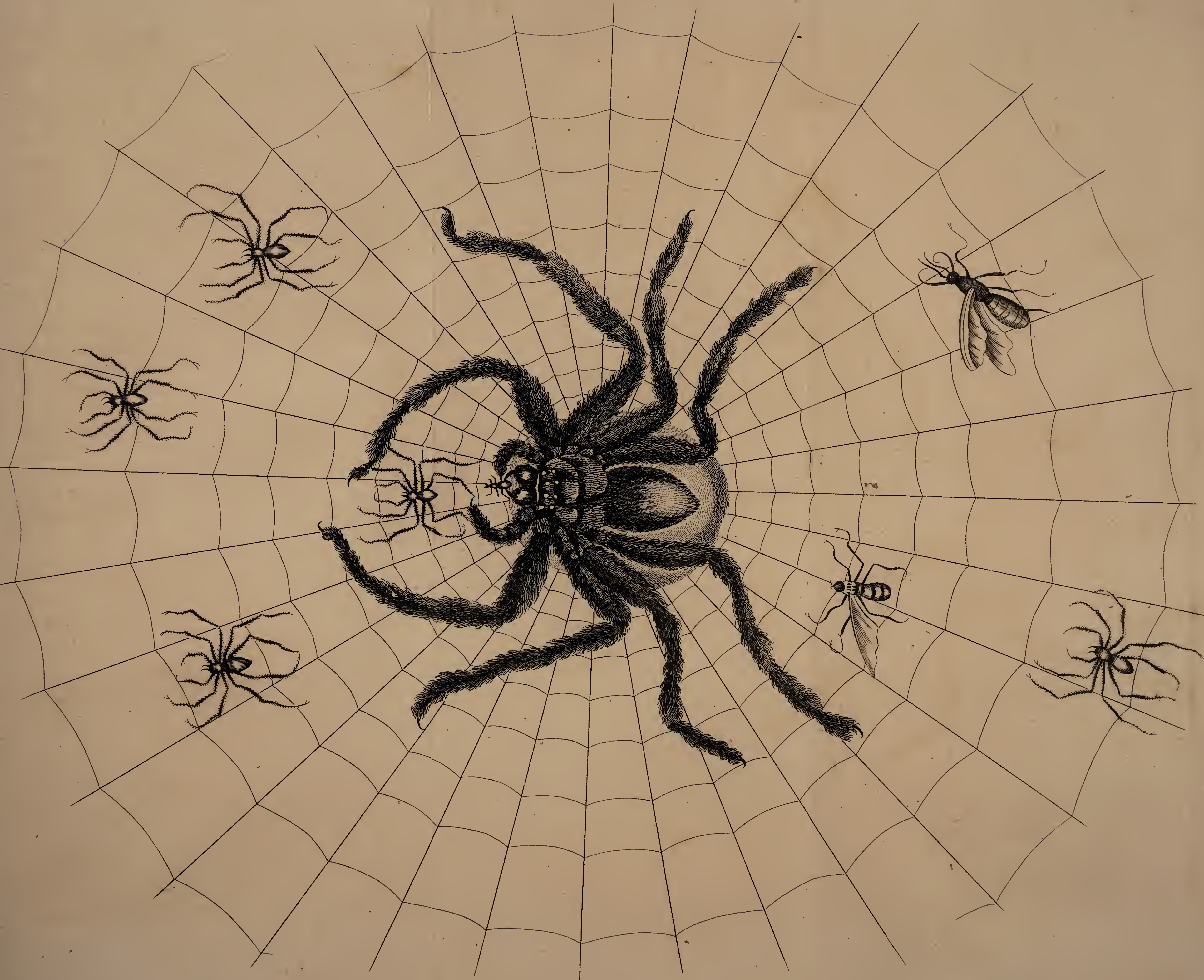
† M. Reaumur ascribes, to this inclination of devouring one another, the scarcity of spiders, considering the vast number of eggs they lay: besides, they are also devoured in turn by the Sphex and Ichneumon. Among other objections urged by M. Reaumur to M Bon's plan is, that the spider's thread cannot be wound off like that of the silk-worm, but must necessarily be carded off; by which means its evenness and lustre is destroyed.

The bite of the tarantula is said to occasion inflammation, difficulty of breathing, and sickness. Dr. Mead, and other medical men, have, however, countenanced the absurd story of these effects being counteracted by music. This is proved to be nothing more than a trick practised on credulous travellers. Mr. Swinburne, when in Italy, minutely investigated every particular relative to this insect. The season was not sufficiently far advanced, and it was pretended that no persons had that year been yet bitten: he, however, prevailed upon a woman, who had formerly been bitten, to perform the dance before him. Several musicians were summoned, and she performed it (as every one present assured him) to admiration. At first she lolled stupidly on a chair, while the instruments played a dull strain; they touched at length the chord supposed to vibrate to her heart, and up she sprung with a hideous yell, staggered about the room like a drunken person, holding a handkerchief in both hands, raising her hands alternately, and moving in true time. The scene, however, was unpleasant, and the dance was terminated.

Wherever the dance is to be performed, a place is prepared for the dancers, hung round with ribbons and bunches of grapes. The patients are dressed in white, with red, green, or yellow ribbons; on their shoulders they have a white scarf; they let their hair fall loose about their ears, and throw the head quite back.

The Encureck is a venomous insect found in Persia, and a kind of tarantula. According to Olearius, quoted by Boyle, it neither stings nor bites; but lets fall its venom like a drop of water, which causes insufferable pain in the part for a time, and afterwards so profound a sleep, that nothing can awake the patient except the ridiculous expedient of crushing one of the creatures on the part affected.

The Barbary Spider, (*Aranea Fasciata.*)—This animal is silvery, with yellow bands round the belly, and duskish hairy jointed legs, and as large as the thumb. It inhabits hedges and thickets, and spreads



FASCIATA OR BARBARY SPIDER.

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its snares for wasps, drones, and even locusts. The animal which it entangles is soon killed by the spider, and if only partly eaten, the rest is concealed under some dry leaves, covered with a web and blackish glue. Its larder is plentifully stored. Its nest is about the size of a pullet's egg, divided horizontally, and suspended by the threads of the insect. It carries its eggs in a bag under its belly, from which the young ones come out, and for a time, in the same web, live in amity; but, when grown up, are mortal enemies. They never meet but they fight; and the battle generally ends with the death of one of the parties. The dead body is carefully stowed away in the larder. Twelve of these spiders, by way of cruel experiment, were once shut up together; and, after a battle of eight days, the strongest only remaïned alive.

The annexed Engraving exhibits the Barbary Spider in his web, at the moment of seizing his prey.

The Great American Spider, (Aranea Avicularia,) is one of the largest of the tribe. Its back is covered with a hard, thick, brown coat. The body is large and rotund, growing out into two parts. The whole body, (except the back) and all the six feet, are covered with long bushy hair. The legs extend over a space of nearly ten inches, and are as thick as a goose's quill. It is not uncommon in many parts of America, but is principally found in the southern division of that continent, and particularly in Guiana.

Captain Stedman, while residing in Surinam, had one of these insects, which he put into a case-bottle eight inches high; and, when this was filled with spirits, the animal reached the surface with some of its claws, while others rested on the bottom. On the whole, he says, these spiders are so hideous, that the very sight of them occasions a tremor of abhorrence, even in persons most accustomed to view them.

This spider resides in trees, and frequently seizes on small birds, which it destroys by sucking their blood, after having first wounded them by its fangs, which distil a poisonous liquid into the wound. The slit or orifice near the tip of the fangs, through which the poison is emitted, is so visible, as to be distinctly perceptible even without a glass. The eight eyes are placed in front of the thorax, somewhat in the form of an oblong square.

The Prickly Spider, (Aculeata.)—This singular species is found in the island of Curacao, in America. It has six feet, and a small mouth like that of the *avicularia.* If a sheep or cow, bitten by this spider, drink water when wounded, it dies in twenty-four hours. When a man is bitten by it, the cure is very difficult, and the patient seldom recovers.

In Jamaica, says Mr. Bingley, there is a kind of spider, the female of which digs a hole in the earth obliquely downward, about three inches in length, and one inch in diameter; this cavity she lines with a tough thick web, which, when taken out, resembles a leathern purse; but, what is most curious, this house has a door with hinges, like the operculum of some sea-shells; and herself and family, who tenant this nest, open and shut the door whenever they pass or re-pass. In some places in the forests of Java, the webs of spiders have been found woven with threads of so strong a texture as not easily to be divided without a knife.

According to Dampier, there is at Campeachy, in New Spain, "a sort of spiders of prodigious size, some nearly as big as a man's fist, with long and slender legs, like the spiders in England. They have two fangs, each an inch and half long, and of a proportionable thickness, which are black as jet, smooth as glass, and at their small end as sharp as a thorn; these are not straight, but bending. Some persons wear them in their tobacco-pouches, to pick their pipes with; others preserve them for tooth-picks. The backs of these spiders are covered with a dark yellowish down, as soft as velvet. Some say they are venomous, and others that they are not; but which of these accounts is to be credited, I cannot determine."

Spiders frequently change their skins, which are often found in the webs, dry and transparent, with the mandibles attached. When about to cast their covering, they suspend themselves in some corner, and creep out of a crack on their back, gradually withdrawing their legs from the skin, as if from a glove. They have likewise power to reproduce their legs.

As Sir Joseph Banks was writing in his study, a web-spinning spider, of middle size, holding a fly in its mouth, passed over some papers on the table. Surprised to see such a spider walking with its prey, and struck with something unusual in its gait, he placed it in a glass for examination; when, instead of eight, he perceived it had only three legs, which accounted for its inability to spin its web; but the curious circumstance of having changed its usual economy, and become a hunting instead of a spinning spider, with a wish to learn whether its legs would be renewed, induced him to keep the animal, and observe its conduct in the glass, from whence it could not escape. On the following morning the animal ate two flies, by sucking the juices, but left the carcasses entire. Two days afterwards, it devoured the body and head of a fly, leavings only the wings and legs. After this time, it sometimes sucked and sometimes ate the fly. At first it consumed two flies in a day, but afterwards one in two days. Soon after its confinement, it attempted to form a web on the side of the vessel, but performed the business very slowly and clumsily, from the want of the proper number of legs. In about a fortnight it had completed a small web, upon which it generally sat.

In a month it shed its skin, leaving the slough on the web. After this change five new legs appeared, not half as long as the other three, and of little use in walking. These new members, however, extended a little in three days, and became half as long as the old ones. The web was now increased, and the animal continued immoveably sitting on it in the day-time, unless drawn from it, or attracted by a fly thrown to it. Twenty-nine days afterwards it again lost its skin, leaving the slough hanging in the web, opposite to a hollow cell it had woven, so as to prevent it from being completely seen when lodged in it. The legs were now larger than before the change of skin, and they grew somewhat longer in three or four days, but did not attain the size of the old legs. The animal now increased its web, and being put into a small bowl, as a more commodious residence, soon renewed a better web than the first.

Pelisson having, by his writings, offended the French government, was thrown into a cell of the Bastille, where (as usual during the reign of Louis XIV.) the prisoners were debarred the visits of their friends, and lived on bread and water, without the comfort of any book whatever, or the use of pen and ink. After a few months of confinement, life was almost become insupportable to poor Pelisson, when he became acquainted with a spider, which he rendered familiar by giving it crumbs of bread; and the insect used to spin down for the same on seeing the captive at his meals. From that period, Pelisson's sufferings were softened, as the care of the spider afforded him both employ and amusement; he considered that he was no longer alone, and found comfort in that thought. However, one day the gaoler brought the bread and water later than usual, and was in the cell when the spider spun down for his accustomed repast; to which immediately Pelisson threw a few crumbs. The sight highly offended the gaoler, who loaded the prisoner with reproaches for so vile an amusement, as he called it; and, with one of the large keys in his hand, he unmercifully killed the poor insect, which, for the first time, made Pelisson shed tears.

Shenstone, the wailing poet of Leasowes, has written the following beautiful lines on the spider:

Artist, who underneath my table
  Thy curious texture has display'd!
Who, if we may believe the fable,
  Wert once a lovely, blooming maid!

Insidious, restless, watchful spider,
  Fear no officious damsel's broom,
Extend thy artful fabric wider,
  And spread thy banners round my room.

Swept from the rich man's costly ceiling,
  Thou'rt welcome to my homely roof;
Here may'st thou find a peaceful dwelling
  And undisturb'd attend thy woof.

While I thy wond'rous fabric stare at,
  And think on hapless poet's fate;
Like thee confin'd to lonely garret,
  And rudely banish'd rooms of state.

And, as from out thy tortur'd body
  Thou draw'st thy slender string with pain,
So does he labour, like a noddy,
  To spin materials from his brain:

He, for some fluttering tawdry creature,
  That spreads her charms before his eye;
And that's a conquest little better
  Than thine o'er captive butterfly.

Thus far 'tis plain we both agree,
  Perhaps our deaths may better show it—
'Tis ten to one but penury
  Ends both the spider and the poet.

THE SCORPION.

Scorpio Europæus.—The body is of an obscure brown; the legs and last joint of the tail are brownish yellow, not forked, but rounded at the end. The belly and belly-fins are reddish. It has eight feet, besides two frontal claws, of a brownish yellow; the eyes are eight in number, three on each side of the thorax, and two on the back. It has two claw-shaped palpi, a long jointed tail, with a pointed weapon or sting at the extremity; it has likewise two combs betwixt the breast and abdomen. The species are all natives of southern climates.

In several parts of Europe it is too well known, though seldom above four inches long; but, in the warm tropical climates, it is seen a foot long, and every way as large as a lobster, to which it has some resemblance. The scorpion's head seems jointed to the breast; in the middle are two eyes, two eyes more in the fore part of the head, but so small, that they are scarcely perceivable; and probably the animal has little occasion for seeing. The mouth has two jaws; the undermost divided, and the parts notched into each other, serving as teeth, and to break its food, and thrust it into its mouth; these the scorpion can so retract, that no part can be seen. On each side of the head are two arms, of four joints, the last large, with strong muscles, and like a lobster's claw. The belly is divided into seven little rings; from the lowest of which is continued a tail, of six joints, bristly, and like little globes, the last being armed with a crooked sting; that fatal instrument that renders this insect so formidable: it is long, pointed, hard, and hollow; pierced near the base by two small holes, through which, when the animal stings, it ejects a drop of poison, white, caustic, and fatal. The reservoir of this poison is a small bladder near the tail, into which it is distilled by a peculiar apparatus. When greatly pressed, the venom is seen issuing out through both holes; so that, when the animal stings, the bladder is pressed, and the venom issues through the apertures into the wound.

Few animals are more formidable, or truly mischievous, than the scorpion, taking refuge in a small place, and being generally found sheltering in houses, it must frequently sting those among whom it resides. In some towns of Italy and France, they are one of the greatest pests that torment mankind; but its malignity in Europe is trifling, compared to what the natives of Africa and the East experience. In Batavia, they grow twelve inches long; and, in removing any piece of furniture, there is the utmost danger of being stung by them. Along the Gold Coast they are often larger than a lobster, and their sting is inevitably fatal. In Europe, however, they are not so large, venomous, or numerous; their general size being two or three inches; and its sting seldom fatal. Maupertuis made several experiments on the scorpion of Languedoc, and found it less dangerous than had till then been represented. He provoked one to sting a dog in three places without hair. In an hour the poor animal seemed greatly swollen, and became very sick; he then cast up whatever he had in his bowels; and for three hours continued vomiting a whitish liquid; the belly was always much swollen prior to the animal vomiting; but that always abated the swelling; and he alternately swelled, and was thus emptied, for three hours; after this he fell into convulsions, bit the ground, dragged himself along upon his fore feet, and at last died, five hours after being bitten. He was not particularly swollen round the place bitten, as is usual after the sting of a wasp or a bee; but his whole body was inflated, and there only appeared a red spot on the places where he had been stung. A similar experiment was, however, some days after, tried upon another dog, and even with more aggravated cruelty; yet he seemed unaffected by the wounds; but, howling a little when he received them, continued alert and well; and soon after was set at liberty, without showing the smallest symptoms of pain: and so far was this poor creature from being terrified at the experiment, that he left his own master's house, to come to that of the philosopher, where he had received more plentiful entertainment. The same experiment was tried by fresh scorpions upon seven other dogs, and three hens; but not the smallest deadly symptom ensued: consequently many circumstances, utterly unknown, contribute to give efficacy to the scorpion's venom. Whether food, long fasting, the season, the nature of the vessels it wounds, or its state of maturity, contribute to, or retard, its malignity, has yet to be ascertained. In these trials, Maupertuis employed scorpions of both sexes, newly caught, vigorous, and active. Their success shows that many of those boasted antidotes, given for the cure of the scorpion's sting, owe their efficacy rather to accident than intrinsic virtue: they only happen to cure when the sting has been no way dangerous; but, in cases of actual malignity, might probably be unserviceable.

The scorpion of the tropics being much larger than those for whose cure such boasted antidotes are given, is probably more venomous. Helbigius, who resided for many years in the east, avers he was often stung by the scorpion, without any material injury, except a painful tumor generally ensuing; but he always cured it by rubbing the part with a piece of iron or stone, same as he had seen the Indians practise, until the flesh became insensible. Others, however, give a very different account of the scorpion's malignity; and assert, that, unless speedily relieved, the wound becomes fatal.

No other animal in creation seems endued with such an irascible nature. They have often been seen, when taken and put into a place of security, to exert all their rage against the sides of the glass vessel that contained them. They will attempt to sting a stick put near them; and attack a mouse or a frog, while those animals are far from offering any injury. Maupertuis put three scorpions into the same vessel with a mouse, which they soon stung in different places: the mouse, thus assaulted, stood for some time upon the defensive, and at last killed them all. He tried this experiment to see whether the mouse, after it had killed, would eat the scorpions; but the little quadruped seemed satisfied with the victory, and even survived the severity of his wounds. Wolkamer tried the courage of the scorpion against the large spider, by inclosing several of both kinds in glass vessels. The success of this combat was very remarkable. The spider at first used all its efforts to entangle the scorpion in its web, which it immediately began spinning; but the scorpion rescued itself from the danger, by stinging its adversary to death; it soon after cut off, with its claws, all the legs of the spider, and then sucked all the internal parts at its leisure. If the scorpion's skin had been less hard, Wolkamer is of opinion that the spider would have obtained the victory; for he had often seen one of these spiders destroy a toad.

The fierce spirit of this animal is equally dangerous to its own species, scorpions being inveterate enemies to each other. Maupertuis put a hundred together in the same glass; and they scarce came into contact ere they began to exert all their rage in mutual destruction: there was nothing to be seen but one universal carnage, without distinction of age or sex; so that, in a few days, there remained only fourteen, which had killed and devoured all the others. But their unnatural malignity is more apparent in their cruelty to their offspring. He enclosed a female scorpion within a glass vessel, and she was seen to devour her young as quick as they were excluded: only one of the number escaped the general destruction, by taking refuge on the back of its parent; and it soon after revenged the cause of its brethren, by killing the old one in its turn.

It is asserted, that, when driven to an extremity, the scorpion will often destroy itself. The following experiment was ineffectually tried by Maupertuis: "But," says Goldsmith, "I am so well assured of it by many eye-witnesses, who have seen it both in Italy and America, that I have no doubt remaining of its veracity. A scorpion, newly caught, is placed in the midst of a circle of burning charcoal, and thus an egress prevented on every side: the scorpion, as I am assured, runs for about a minute round the circle, in hopes of escaping; but, finding that impossible, it stings itself on the back of the head; and in this manner the undaunted suicide instantly expires."

Happily for mankind, these animals are thus destructive to each other; else they would multiply so as to render some countries uninhabitable. The male and female are distinguishable; the male being smaller and less hairy. The female brings forth her young alive and perfect. Redi, having bought a quantity of scorpions, selected the females, and put them into separate glass vessels, and kept them some days without food. In five days, one brought forth thirty-eight young ones, well shaped, and of a milk-white colour, which changed every day more and more into a dark rusty hue. Another female, in a different vessel, brought forth twenty-seven of the same colour; which, the day following, seemed all fixed to the back and belly of the parent. All these continued alive and well near a fortnight; but afterwards some died daily; until, in about a month, they all were dead, except two.

Campbell saw four scorpions put into a hole dug in the earth. They soon began to fight. The mode was curious. Having two claws like a crab's, with these they attempted to seize each other by the head. When one happened to be thus caught, he seemed sensible of his danger, and cried out; but the other, regardless of his cries, turned round his tail, and gave him one sting. The one that was stung, as if aware of its mortality, resisted no more, but lay down till he died. The other, as if aware of the same thing, gave himself no further trouble. They all had the same method of fighting, and all the vanquished acted in the same manner. The surviving conqueror was put to death, as too dangerous to be allowed to escape.

The reader has now been conducted through the seven orders of insects, and the details of the most interesting species.

We may have been accustomed to look upon insects as so many rude scraps, or the refuse of creation: whereas, on examining them, they appear some of the most finished specimens of omniscient workmanship. Many are decked with profuse finery; their eyes are an assemblage of microscopes; their dress has all the variety of colours and lustre of the most brilliant gems, and bordered with fringes richer far than the most costly silks. Their wings are the finest expansion imaginable; cambric is as mere coarse canvass, and lawn as sackcloth, compared with those inestimable webs. The cases of their wings have the most glossy varnish, the finest ornamental fluting, the most radiant studs, or pinked with elegant holes. Each is equipped with weapons, or endued with dexterity, to qualify it to seize its prey, or escape its foe.

Every person admires the majestic horse: with what grace he carries his rider; and with what dauntless bravery he rushes into the thickest ravages of the battle. Yet the little grasshopper springs with a bound altogether as brisk, if not more impetuous. The ant, in proportion to its size, is equally nimble, equally strong; and will climb precipices never traversed by the most courageous courser. The snail is slow in her motions, but she never needs to tread back the ground which she has passed. Even the spider, though abhorred by mankind, lives upon ravage, by entrapping the idle, insignificant, sauntering fly; she spins a clammy thread, and weaves it into a tenacious net: and, as expert as the practised sportsman, she always spreads it in the most opportune places. When winter chills the world, and no insects infest the air, foreseeing that her labour would be vain, she discontinues her work, and abandons her stand.

Nor must we forget the little monarchy of the hive. The bees subsist, not as a lawless banditti, but a regular community: they earn a livelihood by honest industry; nor glut themselves with carnage, or enrich themselves by rapine. Though made for peace, they can use the sword; can arm with the utmost intrepidity, when requisite to guard their stores, or repel their foes. They know that the vernal gleams, and summer suns, continue but for a season; and hence they lay up a balmy treasure, to supply them till the blossoms open afresh, and the flowery harvest returns. The despised butterfly, and loathed caterpillar, exhibit an attire no less sumptuous than the gaudy peacock.

The utility is not less conspicuous of insects. Man has ever, on some occasions, made them subservient to his will. Thus, the bee collects honey for his use; the moth, under his influence, affords him silk; the cantharis, an active drug; the cochineal, his most brilliant dye. Even those beyond his control, minister to his wants: as eggs, maggots, grubs, caterpillars, aureliæ, and flies, they furnish food for innumerable creatures that augment his comforts. But, as the scavengers of the universe, these puny beings are chiefly advantageous to man, and all animated nature. Without their unceasing aid, the air would be so tainted with noxious effluvia, as would soon end animal existence. Having performed the menial task assigned them, they enter into a superior state, wherein they perform another part the most opposite, after a temporary death. The unsightly grub awakens into new life, deserts the clod it lately inhabited, nauseates its former food, sports in the sun-beam, and sips the balmy dew; nor does the butterfly, attired most gorgeously, seem to claim the most distant alliance with the ugly caterpillar, whence it sprang. The attraction of sex forms the chief business of this existence; food is neglected, and its life is devoted solely to amorous dalliance. Having provided a numerous progeny of voracious labourers, it leaves this transitory scene, to those destined to supply its important place in the universe.

LECTURE XLVIII.

CRUSTACEOUS ANIMALS.

How sweet to trace in Nature's each design
The signature and stamp of Power Divine
Contrivance exquisite performed with ease,
Where unassisted sight no beauty sees;
The shapely limb, and lubricated joint,
Within the small dimensions of a point;
Muscle and nerve miraculously spun,
His work, who speaks, and it is fully done.—COWPER.

CRAB TRIBE.

CRABS in general are aquatic animals, whose residence is in the sea; some, however, frequent rivers; and, in America, there are some wholly terrestrial. They feed on aquatic or marine plants, small fish, molluscæ, or dead bodies. The females carry their ova under their tail, which, for that purpose, is, in general, much broader than that of the males.

The Land Crabs are natives of the Bahamas, and of most of the other islands between the tropics. They live in the clefts of rocks, the hollows of trees, or in holes which they dig for themselves in the mountains. Every year they descend, in a body of some millions at a time, to the sea-coast, to deposit their spawn. They march in a direct line to their place of destination, and are said seldom to turn out of their way on account of intervening obstacles. Even if they encounter a lofty wall, or a house, they will attempt to scale it; and they are as regular in their procession as an army under the direction of an experienced commander, being generally divided into three battalions.

These animals measure about six inches across the body. They vary in colour, but are commonly of a blackish violet colour: some are entirely black, others yellow or red, and others variegated. They are distinguished from other species of crabs by having the first joint of the legs spinous, and the second and third furnished with tufts of hair.

They subsist on vegetables, and seldom venture out from their retreats. When the crabs perceive themselves attacked, they throw themselves on their back, and, with their claws, pinch whatever they happen to fasten on. The crab-catchers, however, seize them by the hind legs in such manner, that the nippers cannot touch him. They are caught in their holes by the sea-side, by so fixing a stick as to prevent their escaping: and soon afterward the tide enters the holes, and the animals are drowned. Wafer says, that the inhabitants of some of the Caribbee islands, when they have caught these crabs, put them for three or four days into a piece of potato-ground, in order to render their flesh more firm, and better eating.

Cancer Pagarus.—This species is the common crab of Britain. It is in season between Christmas and Easter, and about harvest; being much esteemed as food. In summer, it abounds on all our rocky coasts, especially where the water is deep. At low tide, the male and female are often found in holes of rocks; and if the male be taken away, another will be found in the hole at the next recess of the tide. By knowing this fact, an experienced fisherman, after having discovered their haunts, may twice a day take, with little trouble, a vast number of specimens. In the winter, they are supposed to burrow in the sand, or to retire to the deeper parts of the ocean. They are taken in wicker-baskets, resembling mouse-traps, or in large nets with open meshes, placed at the bottom of the ocean, and baited with garbage.

Dr. Darwin says, that a hard-shelled crab always stands centinel, to prevent the sea-insects from injuring the rest in their defenceless state; and that, from his appearance, the fishermen know where to find the soft ones, which they use for baits in catching fish; adding that, though the hard-shelled crab, when he is on duty, advances boldly to meet the foe, and will with difficulty quit the field; yet at other times he shows great timidity, and is very expeditious in effecting his escape: if, however, he be often interrupted, he will, like the spider, pretend to be dead, and will watch an opportunity to sink himself into the sand, keeping only his eyes above.

The tips of the claws of this animal are used in medicine, to absorb acidity in the stomach and bowels. The curious economy of the Pagarus attracted the attention of the ancients. One species is well described by Aristotle. All the species are parasitical; inhabit the cavities of turbinated univalves; all change their habitation during their growth, first occupying the smallest shells, and latterly those of considerable dimensions. The abdomen is naked and slender, covered merely with a delicate skin; its extremity furnished with appendages, by which it secures itself within the shell. With surprising facility do these animals move, bearing the shell, destined both to preserve the body from injury, and to guard from the attacks of fishes, who would else devour them. All the species are termed indiscriminately, *Soldier-crabs* and *Hermit-crabs,* from their living in a tent, or retiring to a cell.

Mr. Collinson was shown an experiment, to prove the extremely tenacious disposition of the crab. A fisherman, by irritation, made a crab seize one of its own small claws with a large one. The animal did not distinguish that it was itself the aggressor, but exerted its strength, and soon cracked the shell of the small claw. Feeling itself wounded, it cast off the piece in the usual place, but continued to hold with the great claw for a long time afterwards.

This species is found on the rocky coasts of Europe and India; and is almost the only species that is eaten in this country.

THE LOBSTER

Inhabits the European Ocean; it is found in very great abundance in the North of Scotland, but it is much more common on the coast of Norway, whence the London markets are mostly supplied. Some are caught with the hand, but the greater number in pots; a sort of traps formed of twigs, and baited with garbage. These are formed like a wire mouse-trap, so that, when the lobster gets in, there is no means of escape. They are fastened to a cord sunk into the sea, and their place is marked by a buoy.

They breed during the early summer-months, and are very prolific, Baxter having counted no less than 12,444 eggs under the abdomen. In warm weather they are very active; they have the power of springing backward in the water to a most astonishing distance into their holes in the rocks. Their food consists of dead animal matter, and also of sea-weeds. The female deposits her eggs in the sand. The lobster was well known to the ancients; it is found as far as the Hellespont, and is called at Constantinople, *liczuda* and *licpuda.* They are caught in such abundance on the coast of Northumberland, that, about the year 1769, the sum paid for the annual exports from Newbiggin and Newton, by the sea, amounted to nearly £1500. These animals are able to run nimbly in the water, and when frightened, they will spring from a considerable distance to their hold in the rock. They will throw themselves into their hold in that manner, through an entrance scarcely sufficient for their bodies to pass; as is frequently seen by the people who catch lobsters at Filey Bridge, near Scarborough, in Yorkshire. When the claws of lobsters become inconvenient to the animals, from being injured, they always break them off. They change their shell annually, and previous to their putting off their old one, they appear sick, languid, and restless. They acquire a new coat in a few days; but during the time they remain defenceless, and retire to some lonely place. The new shell is at first quite membranaceous, but hardens by degrees, and it is only while in a soft state that they grow in size.

The boiling of crabs and lobsters alive is a horrid custom, at which every human heart recoils with just indignation, that such abuses should be practised, merely to satisfy the caprice of a vitiated appetite. They are immersed in boiling water, and their piteous shricks seldom fail to excite the heart-rending compassion which is either unknown or not considered, to the disgrace of those who countenance such cruelties.

THE PRAWN AND SHRIMP.

The Prawn has a long horn in front of its head, compressed vertically, serrated both above and below, and bending somewhat upward. The thorax is smooth; the claws are small; and the intermediate antennæ on each side are treble.

They are found in the vicinity of rocks near the shore. Their usual mode of swimming is on their backs; but, when threatened with danger, they throw themselves on one side, and spring backward to very considerable distances. They feed on small marine animals. In their turn, they are the prey of numerous species of fish; although the sharp and serrated horn in front of their head constitutes a weapon of defence against the attacks of all the smaller kinds. They are eagerly sought for by fishermen, who catch them either in osier baskets, similar to those employed in catching lobsters, or in a kind of nets, called *Putting-nets*. When fresh, the colour of the prawn is somewhat cinerous; but, when boiled, it changes to a beautiful light red.

There is a variety caught on the Kentish Coast, about half the size of the above, which, when boiled, turns white, and is sold in London under the name of the *White Shrimp*.

There is frequently to be observed a large and apparently unnatural lump at the side of the head, which contains under the thoracic plate, a species of crustaceous animal, which occupies the whole cavity, and there feeds, and perfects its growth. Colonel Montagu has denominated it *Oniscus Squillarum*. "The most incurious person (says this gentleman,) cannot but have noticed the tumour so common on the thorax of the Prawn or Shrimp, during the summer-months, that is occasioned by the lodgment of this animal, whose growth occasions the distortion of the shell. This tumour forms a secure asylum for the production of the more than usually soft and membranaceous bodies of the parasitical *Onisci*.

The Shrimp is considerably smaller than the Prawn, and, in place of the horn above mentioned, it has two thin projecting laminæ. The claws have a single hooked moveable fang. The intermediate antennæ on each side are only double.

It frequents sandy sea-shores in great abundance, and not unfrequently enters harbours, and even the ditches and ponds of salt-marshes. Its habits and economy are, in most respects, similar to those of the rawn.

MONOCULUS.

Most of the insects belonging to this genus inhabit the water, and are exceedingly small. They are both oviparous and viviparous, and live in stagnated waters. They swim, or rather spring, upon the surface of the water, and, when the droughts of summer have dried up the water, they lie in a torpid state till the renewal of their favourite element restores them to life and enjoyment.

The *Monoculus Polyphemus*, or King Crab, is the largest of the crustaceous tribe, and is found in the Indian Ocean, and a pair of them generally swim together. Its shape is flat and circular in the front, and terminates in a long taper-pointed tail. Its colour is a yellowish brown, and its eyes are nearly equi-distant.

Scolopendræ, or Centipede, are formidable insects, infesting Asia, Africa, and South America, and is said to be so common in particular districts, that the inhabitants place the feet of their beds in vessels of water, to prevent their annoyance during the night.

According to Gronovius, all the legs of this animal are venomous; but its most formidable weapons are the two sharp and hooked instruments that are placed under the mouth, with which it destroys its prey. St. Pierre says, that his dog was bitten with a Centipede upwards of six inches in length, and that the wound became ulcerous, and was three weeks in healing. He was highly diverted in observing one of these animals overcome by a vast number of ants, that attacked it in conjunction, and, after having seized it by all its legs, bore it along, as workmen would have done a large piece of timber.

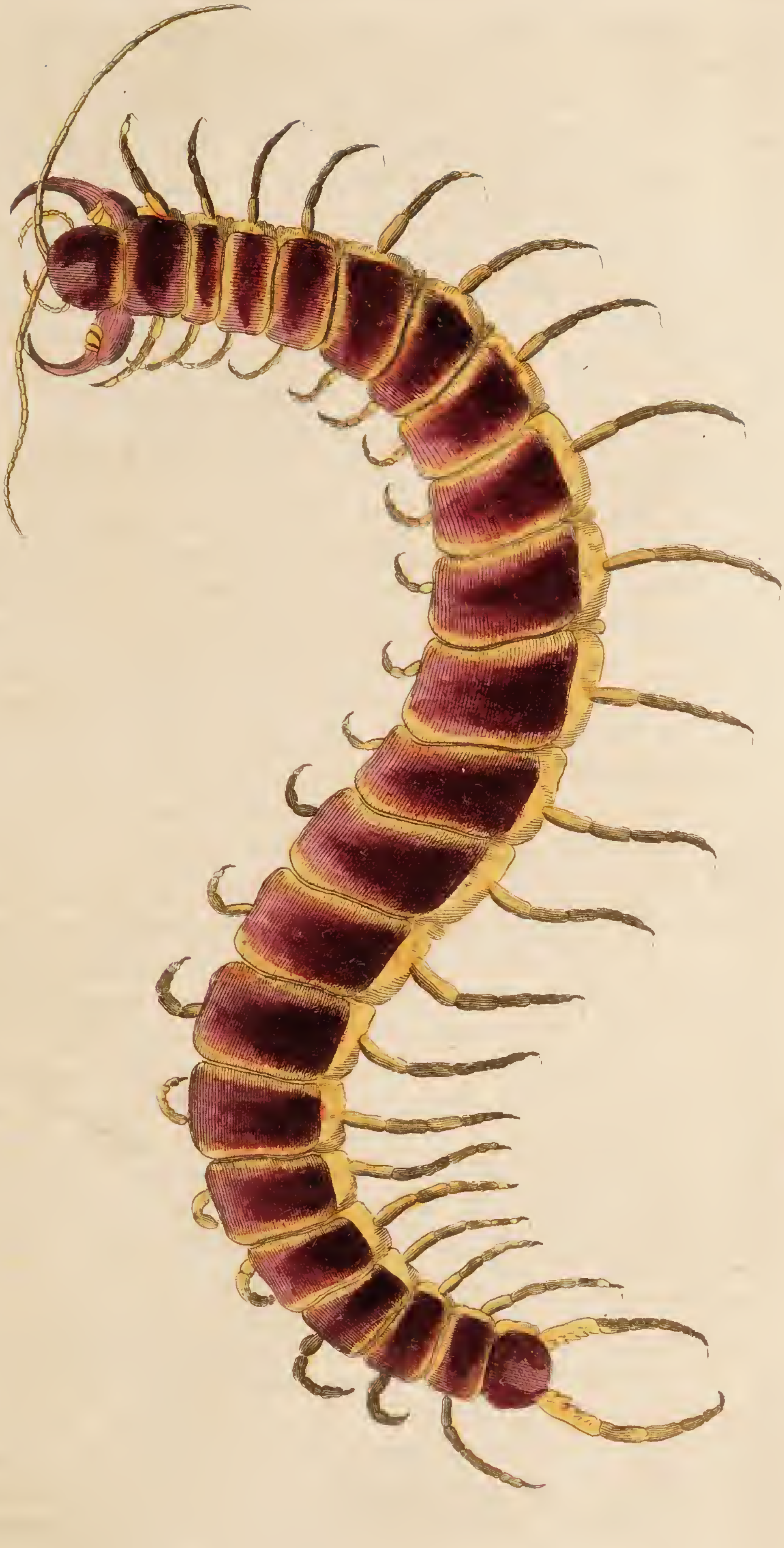
The Scolopendra electrica, when disturbed, emits a phosphoric light of considerable brilliancy. As this appearance has not been noticed whilst the creature is at rest, it is supposed to be a voluntary act, designed as a defence, or a mark of hostility.

FISHES AND AQUATIC ANIMALS.

With wonder mark the moving wilderness of waves,
From pole to pole through boundless space diffused,
Magnificently dreadful! where, at large,
Leviathan, with each inferior name
Of sea-born kinds, ten thousand thousand tribes,
Finds endless range for pasture and for sport.
Adoring own the Hand Almighty, who its bed
Immeasurable sunk, and poured abroad,
Fenced with eternal mounds, the fluid sphere;
With every wind to waft large commerce on,
Join pole to pole, consociate severed worlds,
And link in bonds of intercourse and love
Earth's universal family. MALLET.

And thou, majestic main!
A secret world of wonders in thyself!
Sound His stupendous praise, whose greater voice
Or bids you roar, or bids your roarings fall.—THOMSON.

ICHTHYOLOGY, or the doctrine of the nature of fishes, teaches us, that those beings are very different in construction from that of terrene animals. They have fins instead of legs, with which they move, by reaction, like the power of ears. They inhale water instead of air. Their structure is wonderful. Their bodies are clothed and guarded in the best manner, with scales and shells, suitable to their respective circumstances, the dangers they are exposed to, and their motions, conditions, and habits. They have several parts peculiar to themselves; as fins to keep and balance them upright, and an air bladder to enable them to sink and rise at pleasure. They have little gills or branchiæ, whereby they respire as animals do by lungs. The tail is the instrument of progressive motion. Their eyes are peculiarly formed to enable them to correspond with all the conveniences and divergencies of rays, which the variations of the watery medium and refraction may occasion; in which they bear a



GREAT SCOLOPENDRA OR CENTIPEDE.

London. Published by Sir R. Phillips & Cº. Feb. 10. 1823.

near resemblance to birds. In this manner, the ocean presents us with myriads of its animated beings, in every variety of form. Some, garbed in light scales, swim with amazing swiftness; others, loaded with thick shells, trail heavily along; and others, totally deprived of loco-motion, live and die immoveably fixed to the same rock. As terrestrial animals are furnished with feathers, with down, with warm furs, or with long hair, to defend them from the inclemencies of the air, so are fishes invested with a glutinous matter, perceivable at the first touch, with which the whole surface of their bodies is moistened; the hair, feathers, and oil, being in each case bad conductors of heat, and preventing its too rapid dispersion in the medium in which the animal lives; an exterior strong coating; and before we get to their flesh, an oily substance, which extends from head to tail, and surrounds the whole. These, from their solidity and immiscibility with water, keep their frames firm, and give them vigour and activity. They could not be furnished with a lighter vestment, or one more impenetrable.

There are three grand divisions in the fish kind: the *cetaceous*, or those of the whale kind; the *cartilaginous*, or those who have gristles instead of bones; and the *spinous*, or those who have bones.

All the cetaceous tribe resemble quadrupeds in their internal conformation. They have warm red blood, which circulates through their bodies; similar parts of generation; and lungs, which drive them to the necessity of frequently rising to breathe the air. The breasts of whales are generally two, and are filled with large quantities of milk. The teats are like those of a cow, with which the young is suckled. Some whales have a very small gullet; whereas others, such as the cachelot, can swallow an ox. Fishes of eight or nine feet long are often found in their stomach. The substance called ambergrise, which was long unknown, is found in round lumps, floating in a fluid, in the place where the seminal vessels are usually situated in other animals. And thus it is that the civic, the musk, and the castor, are situated in the inguinal regions of the civic cat, the musk deer, and the beaver. The spermaceit is the brain and oil of the cachelot.

The reasoning powers of fishes, however we may despise them, is wonderful. They have their migrations as well as the fowls of the air: they travel in companies to distant coasts, for the sake of a succession to keep up the species, which, however, they never see, and know nothing of: they all agree, without any voice or signal with which we are acquainted, and undertake the voyage without any apparent consultation one with another: while they know nothing of the course of the stars, or of other phenomena observed above the surface of their element. Thus shoals of cod, haddock, whiting, mackarel, tunney, herring, and pilchard, are annually observed to make their periodical emigrations!

The *crustaceous* kinds of fishes are the lobster, the crab, and the tortoise or turtle.

The *testaceous* are the oyster, the muscle, the cockle, &c. Almost all shell-fish, as well indeed as shell-insects, can mend their own shells. They are born with them: the snail with his little house upon his back, and the oyster with his shell. The reparation is performed with a slimy fluid or mucus, like that of the snail, which they extract from their own juices. All shells are formed of the same substance—of an animal or calcareous earth, which ferments with acids, and burns into lime; and hence the reason why chalks and marbles are said to be shells in a state of decomposition.

Testaceous fishes are divided into the *univalve*, *bivalve*, and the *multivalve*, or a corn-shell kind. The sea-snail, which is of the first kind, has its eyes on the points of its largest horns. Every snail is at once both male and female; and, while it impregnates another, is impregnated itself. The oyster is formed with organs of life and respiration; with intestines which are very voluminous; with a liver, lungs, and heart, and is self-impregnated; but, unlike other shell-fish, is unalterably fixed to one spot.

The mechanical *rationale* of swimming in fishes, is the same as that of flying in birds: the latter fly by striking the air with their wings, and the former by striking the water with their fins; which act and re-act like common levers. Though there is not the least appearance of ears, fishes are not therefore deaf. They have an auricular nerve, as has been explained by Hunter. As to their sense of smelling, this we are at present not thoroughly assured of, though Pontopidan tells us, the fishermen on the coast of Norway always carry musk in their pockets, when they have a prospect of meeting with the sea snake, the smell of which immediately forces the animal to dart away as expeditiously as possible.

The method of respiration is by passing the water, and the air contained in it, through the gills on each side of the head, which are in lieu of the lungs in quadrupeds. Fishes respire water quicker than we do air. This aqueous respiration keeps up the vital principle. The air-pump cannot deprive them of it, and therefore will not kill them; but, the water-pump, by taking away the water, soon makes them expire.* The tongue of fishes shews that they have a sense of taste. The eyes in general are perfect globules, in order that the focal distance may be very short, and of course the vision very distinct of objects near at hand.

How is it to be accounted for, that in lakes, on continents, which had formerly been the *bottom of the sea,* there should be found such abundance of fish, which cannot live in the salt-water element, but from which they must have proceded. The lakes which now are fresh, were, at their origin, probably salt. But, whence came the change? From the condensations of the atmosphere, it is supposed, into rain; and from the melting of snow and ice, in the higher parts of those countries in which lakes and rivers are found. The first overflowings, occasioned by the atmospherical and glacial waters, would not only carry off variety of impurities, but would scoop out the beds of rivers, which attrition in time would widen. By these outlets, aided by an incessant succession of fresh element, the heterogeneous particles might be carried off, till, in process of time, the whole might become limpid and sweet. In regard to the existence of fishes in them, indeed, the matter is not quite so explicable. But may not fishes be supposed to have changed their nature, or their particular habits, in the ratio of a change occasioned in their climate, and in the fluid by which they have been surrounded? We see salmon come every day from the sea into rivers. Porpoises are not unfrequently in rivers, and at a prodigious distance from the salt-water ocean. But where, says Sullivan, did the fishes in the lake of Geneva, for instance, and in all the lakes in Switzerland, and in the neighbourhood of the Alps, come from, if they did not come from the ocean? They did not derive their being from the Glaciers. Either they, or rather their ancestors, were created in the very spots, those parts of the ocean, where their descendants now take up their abode.

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* It has been ascertained that, if the air be extracted from water into which fish are put, they immediately come to the surface, and gasp as if for breath. Hence distilled water is to fish what the vacuum formed by the air-pump is to most other animals. This is the reason why, in winter, when a fish-pond is entirely frozen over, it is necessary to break holes in the ice, not that the fish may come to feed, but that they may come to breathe. Without such precaution, if the pond be small, and the fish be numerous, they will die from the corruption of the water.

The inhabitants of the waters have all soft, oily, moist flesh; and the skeleton, where it exists, is of a lax and porous texture. The more humid crawl at the bottom of the seas; while those which support themselves on the waves, and sport with the storm, have firmer flesh, and quicker and extended senses. Probably only a few of the aquatic tribes are as yet known; every drop of water contains animalculæ; and mud and slime swarm with worms and infusoria; while the polypi raise reefs and islets of coral. Crustacea drag themselves along the shore; mollusca hold to the rocks; while straits and bays abound with cockles, muscles, oysters, &c. Each has its peculiar kind of life and faculties; and, disregarding what is passing around, steadily pursues its own purposes.

Birds know the varieties of winds; fishes, those of waters. Herrings set out from the pole, turn round the continents, and return to the regions of ice. On the approach of spring, legions of anchovies, chad, mackerel, pilchards, and tunnies, from the high seas, distribute themselves along the coasts until the beginning of autumn. The cod goes in shoals to the great bank of Newfoundland; salmon and sturgeon ascend the fresh waters; and in their suite are seen cetacea, sharks, skate, sword-fish, &c. in great numbers.

The want of food excites to these voyages in birds; and to spawn is the cause of fish ascending the rivers; as only in warm and protected waters can the spawn open, and the young animal would assuredly perish were he, on leaving the egg, immediately to be exposed to the fury of the waves. Besides, requiring, at first, light nourishment, the spawn is deposited where worms and insects abound.

Every species chooses its spot, and every individual has its haunt: some live in the high seas, and feed only on crustacea and shell-fish; others, as eels, lampreys, &c. wallow in the mud and in stagnant waters, like web-footed birds; and diodons, telrodons, &c. seek the warm waters and the southern seas; herring, cod, and mackerel, fix in the polar seas. Every sea has its peculiar species, which remain there from choice; as uranoscopes in the Adriatic, mullets on the coasts of Greece, gold-fish in the Indian Sea, snappers in the West Indies, &c. &c. In short, every living creature seeks situations adapted to its powers, wants, and capabilities; and in such situations is always to be found, for in others it could not continue to exist.

Among the fresh-water fish are gudgeons, barbels, eels, carp, pike, trout, perch, and numerous others; of which analogous ones are found also in the sea. How these came to inhabit fresh water, merits some consideration. In different ages, the sea covered the surface of the globe, and in retreating formed lakes in the basins of the mountains, there leaving some of its inhabitants. Thus have been peopled all lakes of primary formation.

Sonnerat found springs so hot, he could not bear his hand in the water, (in Lucon, one of the Philippines,) yet each has its vegetables and fishes. Mosses and worms live in all mineral waters. The *proteus*, that singular animal, which has gills and lungs, and seems equally aquatic and terene, lives only in subterraneous waters, on small shell-fish. The salamanders have no other habitation while bull-heads; the sireus bury themselves in the mud; and so do several reptiles. These facts, and others of the *infusoria*, prove that every part and atom has its inhabitants, which execute their functions.* Equally peculiar is the turtle, which plunges to the bottom of the sea, feeds on algæ and fucus, and comes up to lay its eggs on the sand of desert islands.

The bodies of fishes are generally covered with horny *scales*. They *breathe* by certain organs on each side of the neck, called *gills*. In this operation they fill their mouth with water, which they throw backward so forcibly as to lift open the great flap, and force it out behind. In the passage of this water among the feather-like processes of the gills, all, or at least the greatest part, of the air contained in it is left behind, and carried into the body, where it is fixed in the animal economy.

Fishes are nearly of the same specific gravity with water. Their direct motion is obtained by moving the tail with a vibrating motion; and, by strongly bending the tail sideways, this part of their body acts like the rudder of a ship, and enables them to move in an opposite direction. The *air-bladder* is also of great assistance to fish in swimming, as it is by this they increase or diminish the specific gravity of their bodies. When, by their abdominal muscles, they compress the air contained in this bladder, the bulk of their body is diminished; their weight, compared with that of the water, is increased, and they consequently sink. In rising, they relax the pressure of the muscles, the air-bladder again acquires its natural size, the body is enlarged, and thus they ascend. This bladder lies in the abdomen, in the course of the back-bone. In some fish it is single, and in others double. The air appears to be conveyed into it from the blood, by means of vessels appropriated to that purpose; and it can be discharged thence either into the stomach or the mouth. Some fish, which are destitute of air-bladders, remain at the bottom of the water, unless the form of their body enables them to strike the water downward with great force. The *teeth* of fish are usually situated in their jaws. The *tongue* is in general motionless, obtuse, and fleshy. Being furnished with *nostrils* and olfactory nerves, there can be little doubt that fishes possess the sense of smelling. The *bones* of these animals are formed of a substance between true bones and cartilages: the back-bone, extending through the whole length of the body, consists of vertebræ, which decrease in thickness as they approach the tail; the ribs are attached to the processes of the vertebræ, and enclose the breast and abdomen. The *sight* of fishes is probably the most perfect of all their senses. The eye, in general, is covered with the same transparent skin that covers the rest of the head, to defend this organ in the water, as none of the species have eyelids. The *organ of hearing* is placed at the sides of the skull; but, differing in this respect from that in quadrupeds and birds, it is entirely distinct and detached from it. In its structure, the ear is less complicated than in quadrupeds and other animals that live in the air.

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* As all elastic gas and fluids owe that condition to the motions of their atoms, so power exists every where; the transfer of which is every where competent to support organic life.

Some genera have the external orifice very small; but in others there is no external opening whatever.

Fishes are in general oviparous; but some few produce their offspring alive. The males have the *milt*, and the females the *roe;* but some of the cod and sturgeon tribes contain both. The spawn is generally deposited in the sand or gravel: many of the fish, however, which reside in the ocean attach their ova to sea-weeds. The fecundity of these tribes is truly astonishing: in the spawn of a single cod upwards of nine millions of eggs have been ascertained, and nearly a million and a half have been taken from the interior of a flounder. The spawn of some fishes are propagated by aquatic birds. Eels are thus transported Cranes swallow them alive; and thus fish-ponds may perhaps be frequently stocked.

The longevity of fish is far superior to that of other creatures. Instead of suffering from the rigidity of age, their bodies continue to increase with fresh supplies; and, as the body grows, the conduits of life seem to furnish their stores in greater abundance.

In the royal ponds at Marli, in France, there are some particular fish which, it is said, have been preserved tame since the time of Francis I., and which have been individualy known to the persons who have succeeded to the charge of them ever since that period.

Fishes are divided into seven orders:

1. *Cete;* with fins at the breast, back, and tail,—as the whale, cachalot, dolphin, &c.
2. *Apodal;* with bony gills, and no ventral fins,—as the eels.
3. *Jugular;* with bony gills, and ventral fins before the pectoral ones,—as the cod and haddock.
4. *Thoracic;* with bony gills and ventral fins placed directly under the thorax,—as the turbot, sole, perch, and mackerel.
5. *Abdominal;* with bony gills, and ventral fins placed behind the thorax,—as the salmon, pike, herring, and carp.
6. *Branchiostegous;* with gills destitute of bony rays,—as the pike-fish and lump-fish.
7. *Chondopterygous;* with cartilaginous gills,—as the sturgeon, shark, skate, and lamprey.

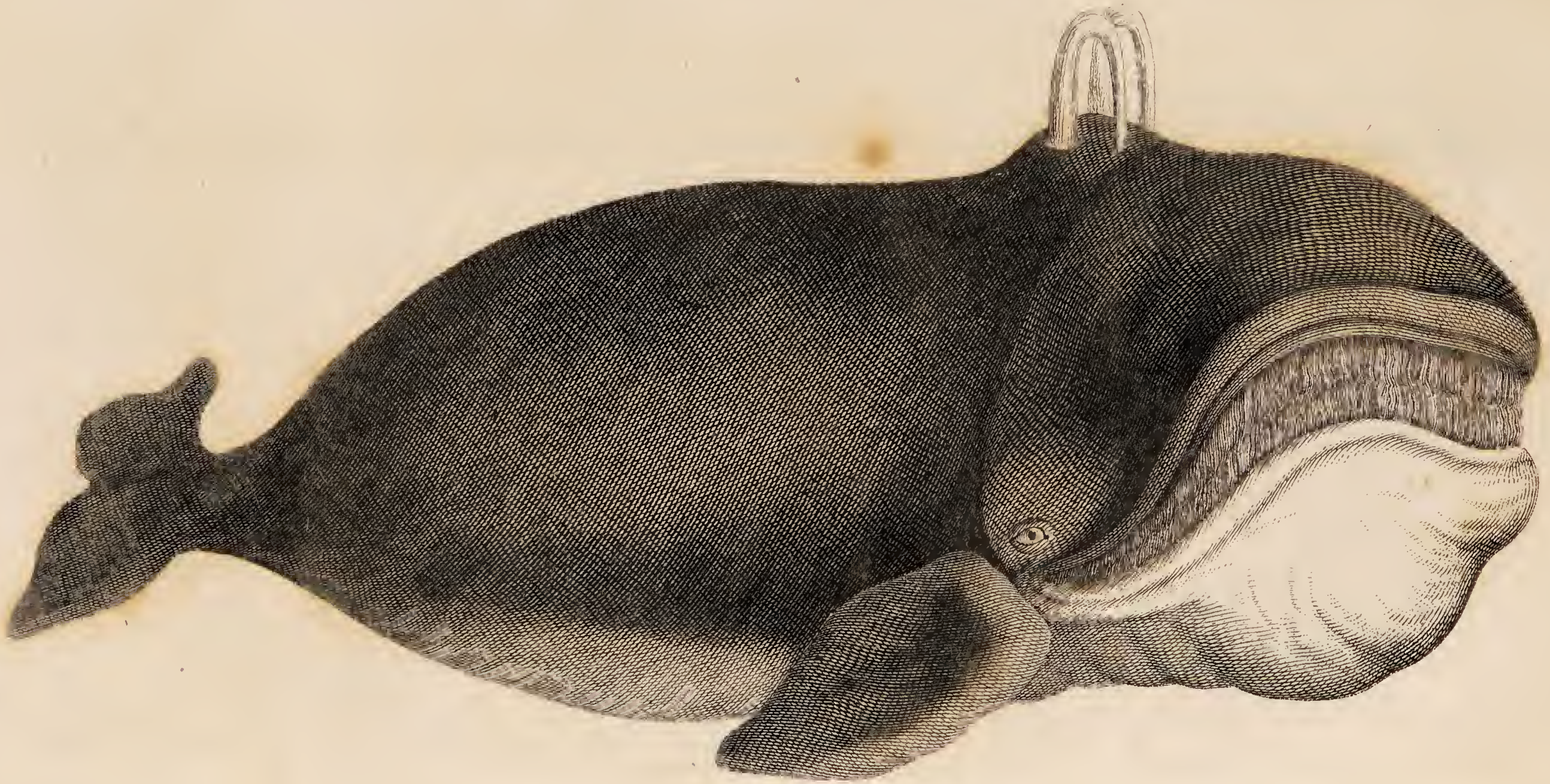
THE UNICORN NARWAL, OR SEA UNICORN.

These animals obtained the name of *Narh-wal*, or whale which feeds on dead bodies, from their having been believed to subsist on such dead and putrid animals as they found floating on the water. Such are their size and bulk, and so powerful are their muscles, that they move in all directions with surprising velocity. The weapon which projects, sometimes to the length of six or eight feet, from their upper jaw, when urged with all their force, will penetrate even into the solid timbers of a ship; and the body of no animal whatever is sufficiently hard to resist its effects. This weapon is a species of tusk, in its substance resembling the tusks of the elephant. These weapons will be found in many cabinets, as the horn of that fabulous quadruped the unicorn. They have occasionally been found broken short off, and deeply buried in the keels and bottoms of vessels. These animals usually swim in troops, and are found in most parts of the Northern Ocean. The Greenlanders pursue and kill them on account of their oil. The blubber, which affords a large proportion of fine oil, is from two to three inches and half in thickness, encompasses the whole body, and is sometimes more than half a ton in weight.

The crew of the Alexander, in their voyage of discovery to the Arctic Regions, in 1818, noticed a large sea-animal, which they supposed to be a narwal. The greater part of it was buried under ice; but they found one of its flippers, which measured fifteen inches in length, and a foot in breadth.

In 1800, an individual of this species, twenty-five feet in length, was stranded near Friestone, in Boston Deeps, Lincolnshire; and another, about eighteen feet in length, was cast ashore and taken alive, not far from Boston, a few years before.

Mr. Scoresby, in his Journal of a Voyage to Greenland, describes the contents of the stomach of a narwal, which were very extraordinary. They consisted of several half-digested fishes, the beaks and other remains of cuttle-fish, and a skate almost entire, measuring two feet three inches in length, and one foot eight inches in width.



THE WHALE.

——Warm and buoyant, in his oily mail,
Gambols on seas of ice th' unwieldy whale;
Wide waving fins round floating islands urge
His bulk gigantic through the troubled surge;
With hideous yawn the flying shoals he seeks,
Or clasps with fringe of horn his massy cheeks;
Lifts o'er the tossing wave his nostrils bare,
And spouts the wat'ry columns into air:
The silvery arches catch the setting beams,
And transient rainbows tremble o'er the streams.—DARWIN.

Hugest of living creatures, on the deep,
Stretch'd like a promontory, sleeps, or swims,
A vast unsightly mass; and at his gills
Draws in, and at his snout spouts forth, a sea.—MILTON.

The ancients have described the whale as being six hundred feet in length; at present it is only found in the northern seas ninety feet in length, and twenty in breadth: but formerly they were taken of much greater size, when the captures were less frequent, and the fish had time to grow. Such is their bulk within the Arctic Circle; but, in the Torrid Zone, many are seen a hundred and sixty feet long, and many weigh one hundred thousand pounds.*

There are many turnings and windings in this fish's nostrils, and it has no fin on the back: the head is very much disproportioned to the size of the body, being one-third the size of the fish; the eyes are remarkably small; and the under lip is much broader than the upper. The tongue is from eighteen to twenty feet long, and composed of a soft spungy fat, capable of yielding five or six barrels of oil; and the gullet is very small for so vast a fish, not exceeding four inches in width. The tail is of an amazing size, and semilunar shape; and the animal employs it very effectively in accelerating its enormous body, which, though so bulky, passes through the water with great rapidity, and leaves a track like that made by a large ship.

This fish varies in colour: the back of some being red, the belly generally white; others are black; some mottled; and others quite white. Their colours in the water are extremely beautiful, and their skin is very smooth and slippery, though often with plants, corallines, and shell-fish adhering. Every species of the whale propagates only with those of its kind, and does not at all mingle with the rest: however, they are generally seen in shoals of different kinds together, and make their migrations in large companies from one ocean to another.

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* Various extraordinary relations have been published in regard to an animal prodigiously larger than the whale, called the *Kraken*. It seems difficult to discredit some of them; yet the love of the marvellous leads to so many impositions, that, till the existence of the kraken is better ascertained, it has been judged proper to omit any account of it in the present work.

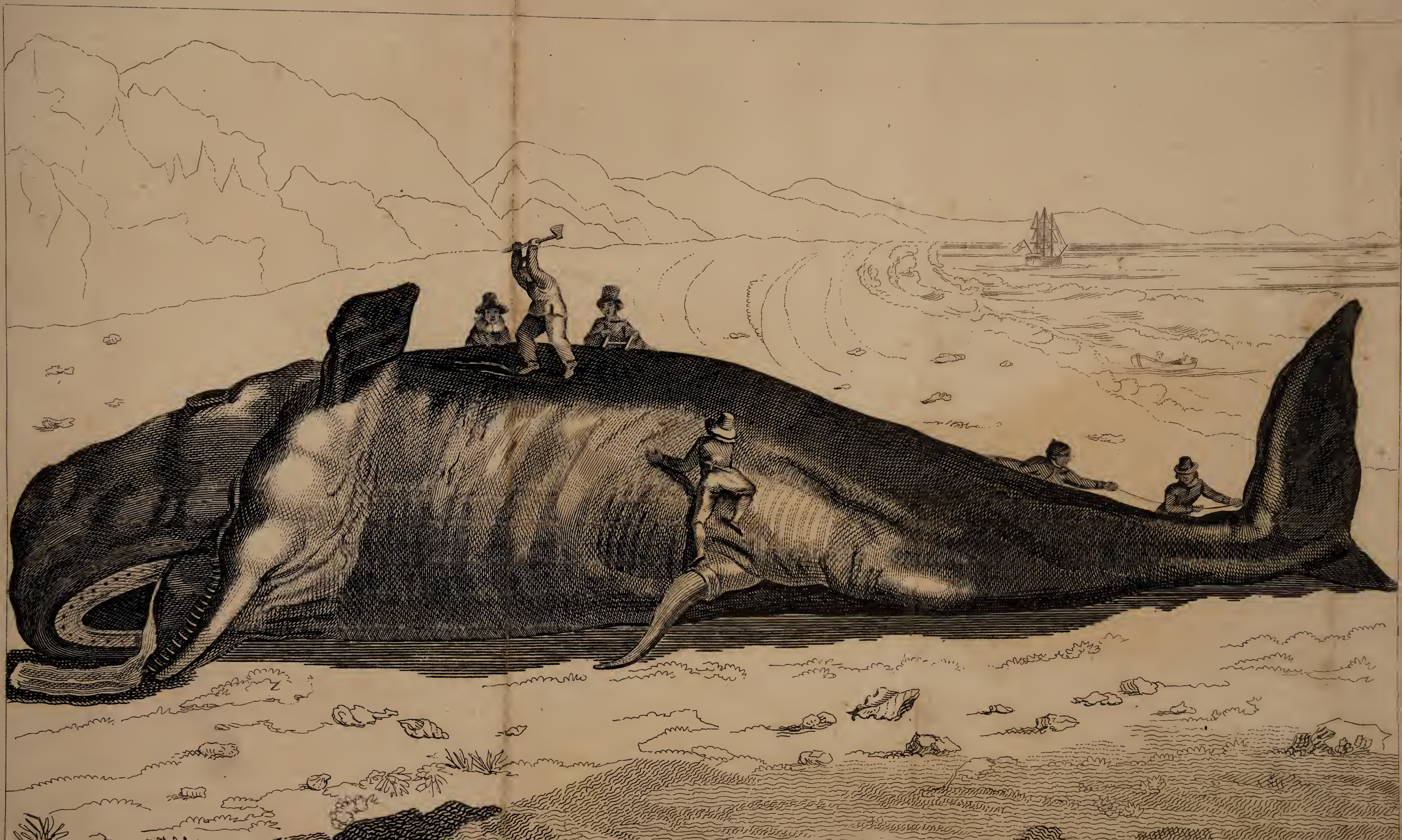
Whales are generally taken in the northern seas. The crews carry out with every ship six or seven boats; each of which has one harpooner, one man at the rudder, one manager of the line, and four seamen to row it; with three or four harpoons, several lances, and six lines, each 120 fathoms long, fastened together. When the whale is struck with the harpoon, it darts into the deep, carrying the instrument off in its body; and so rapid is its motion, that, if the line was to entangle, it would either snap like a thread or overset the boat: one man, therefore, is stationed to attend only to the line, that it may go regularly out; and another is also employed in continually wetting the place it runs against, that the wood may not take fire from the motion. On the whale's return, the cruel harpooner inflicts a fresh wound, till at length, fainting from loss of blood, the men venture the boat quite up to it, and a long steeled lance is thrust into its breast and other parts, which soon unfeelingly puts an end to its existence.

The velocity of the whale is usually about eight or nine miles per hour.

Nature's strange work, vast whales of different form,
Toss up the troubled floods, and are themselves a storm:
Uncouth the sight when they, in dreadful play,
Discharge their nostrils, and refund a sea;
Or angry lash the foam with hideous sound,
And scatter all the watery dust around.
Fearless the fierce destructive monsters roll,
Ingulph the fish, and drive the flying shoal.
In deepest seas these living isles appear,
And deepest seas can scarce their pressure bear:
Their bulk would more than fill the shelvy strait,
And fathom'd depths would yield beneath their weight.

In 1802, Captain Lyons, having discovered a large whale near his ship on the Labrador coast, dispatched four boats in pursuit, when two of them succeeded in approaching it so closely together, that two harpoons were struck at the same moment. The fish descended a few fathoms in the direction of another of the boats, which was on the advance, rose powerfully beneath it, struck it with its head, and threw the boat, men, and apparatus, about fifteen feet into the air.

The *Blunt-headed Cachalot*, or *Spermaceti Whale*, when



full grown, is about seventy feet, and its girth about fifty. When viewed from above, it appears like an immense animated mass, truncated in front, so that the muzzle terminates in a somewhat squared, and almost perpendicular, extremity. The head constitutes nearly one-third of the whole body; the mouth is situated at the under part, and the under jaw is so small, in comparison with the upper, as to have somewhat the appearance of the lid or cover of an enormous box turned upside down. They generally swim in troops, consisting of a great number both of males and females. In March, 1784, there were thirty-two spermaceti whales cast on shore, during a violent gale of wind, in the neighbourhood of Audierne, in France: their bellowing was heard to the distance of more than a league.

THE DOLPHIN.

> As when a Dolphin sports upon the tide,
> Displays his beauties, and his scaly pride;
> His various colour'd arch adorns the flood,
> Like a bright rainbow in a watery cloud;
> He from the billows leaps with gamesome strife,
> Wanton with vigour and immoderate life.—BLACKMORE.

These animals are occasionally seen in almost every part of the ocean. The back is very slightly incurvated, and the body slender; the nose is long, narrow, and pointed, with a broad transverse band, or projection of the skin on its upper part.

All this species have fins on the back; very large heads, like the rest of the whale kind; and resemble each other in their appetites; their manners, and conformation, being equally voracious, active, and roving. No fish could escape them, but from the awkward position of their mouth, which is placed in a manner under the head; and their own agility is so great as to prevent them from being often taken. They seldom remain a moment above water, though their too-eager pursuit after prey sometimes exposes them to danger.

The motions of the Dolphin in the water are performed with such wonderful rapidity, that the French sailors frequently call the Dolphin *la flèche de la mer*, or "the sea arrow." M. de Saint Pierre, in his voyage to the Isle of France, asserts that he saw a Dolphin swim, with apparent ease, round the vessel in which he was sailing, though it was going at the rate of six miles an hour. A shoal of these animals followed the ships of Sir Richard Hawkins upwards of a thousand leagues. They were known to be the same by the wounds they occasionally received from the sailors.

They generally swim in troops, and their motion in the water somewhat resembles the undulating motion of a ship under sail. Their gambols on the surface of the ocean som times afford a most interesting and entertaining spectacle. By curving their body, and suddenly extending it, like salmon and some other kinds of fish, they are enabled to leap to a very considerable height above the surface of the water. When they are in eager pursuit of prey, and sometimes even in their gambols, they spring upwards of twenty feet at a single bound. Falconer, in his poem of the Shipwreck, gives the following beautiful description of the dying dolphin:—

And now, approaching near the lofty stern,
A shoal of sportive dolphins they discern.
From burnish'd scales they beam'd refulgent rays,
Till all the glowing ocean seems to blaze.
Soon to the sport of death the crew repair,
Dart the long lance, or spread the baited snare:
One in redoubling mazes wheels along,
And glides, unhappy! near the triple prong.
Rodmond, unerring, o'er his head suspends
The barbed steel, and every turn attends;
Unerring aimed, the missile weapon flew,
And, plunging, struck the fated victim through;
Th' upturning points his ponderous bulk sustain,
On deck he struggles with convulsive pain.

Historians and philosophers seem to have contended who should invent most fables concerning this fish. It was consecrated to the gods, and was, in earlier times, celebrated for its fondness of the human race. From their leaps out of the sea, they assume a form that is not natural to them. Hence the dolphin is scarcely ever exhibited by the ancients in a straight shape, but almost always incurvated; and the poets describe them much in the same manner.

THE PORPESSE.

In curling wreathes they gambol on the tide,
Now bound aloft, now down the billow glide.
Their tracks awhile the hoary waves retain,
That burn in sparkling trails along the main.
These fleetest coursers of the finny race,
When threat'ning clouds th' etherial vault deface,
Their rout to leeward still sagacious form,
To shun the fury of th' approaching storm.—FALCONER.

This species is found in vast multitudes in all parts of the British seas; but in greatest numbers at the time when fish of passage appear, such as mackarel and herrings, which they follow up the bays with the same eagerness as a dog pursues a hare; in some places they almost darken the sea, as they rise above water to take breath: but porpesses seek for prey not only near the surface, but often descend to the bottom in search of sand-heels and sea-worms, which they root out of the sand with their noses, in the same manner as hogs do in the fields for their food.

In the river St. Lawrence, there is a white kind; and Dr. Borlase, in his voyage to the Scilly Isles, observed a small species, which he calls *thornbacks*, from their broad and sharp fin on the back. Some of these were brown, some quite white, others spotted; but whether they were only a variety of this fish, or whether they were small grampuses, which are also spotted, has not been determined. The porpesse was a royal dish, during the reign of Henry VIII. and from its magnitude must have held a very respectable station at the table; for, in a household book of that prince, extracts of which are published in the third volume of the Archæologia, it is ordered, that, if a porpesse should be too big for a horse-load, allowance should be made to the purveyor. This fish continued in vogue even in the reign of Elizabeth.

THE GRAMPUS.

——— Enormous Grampus, issuing forth
From the pale regions of the icy North,
Waves his broad tail, and opes his ribbed mouth,
And seeks on winnowing fin the breezy South;
From towns deserted rush the breathless hosts,
Swarm round the hills, and darken all the costs;
Boats follow boats along the shouting tides,
And spears and javelins pierce his blubb'ry sides.
DARWIN.

The Grampus is an inveterate enemy to whales, great flocks of them attacking the largest, which they frequently kill and devour. They are also said to attack and devour the seals, which they occasionally find sleeping on the rocks; dislodging them by means of their back fin, and thus precipitating them into the water.

The Grampus is found from the length of fifteen feet to that of twenty-five; and ten in diameter.

It is remarkably thick in proportion to its length, one of eighteen feet being in the thickest place ten feet diameter. Pliny called it "an immense heap of flesh, armed with dreadful teeth." It is extremely voracious; and will not even spare the porpesse, a congenerous fish. It is a great enemy to the whale, on which it will fasten like a dog on a bull, till the animal roars with pain. There are thirty teeth in each jaw; those before are blunt, round, and slender; the farthest sharp and thick: between each is a space adapted to receive the teeth of the opposite jaw when the mouth is closed. The spout-hole is in the top of the neck. The colour of the back is black, but on each shoulder is a large white spot; the sides marbled with black and white; the belly white.

Waller, in one of his poems, relates a story (founded on fact), of the parental affection of these animals. A Grampus and her cub had got into an arm of the sea, where, by the desertion of the tide, they were enclosed on every side. The men on shore saw their situation, and ran down upon them with such weapons as they could at the moment collect. The poor animals were soon wounded in several places, so that all the immediately-surrounding water was stained with their blood. They made every effort to escape; and the old one, by superior strength, forced itself over the shallow, into the ocean. But, though in safety herself, she would not leave her young-one in the hands of assassins. She therefore again rushed in: and seemed resolved, since she could not prevent, at least to share the fate of her offspring. At length, the tide coming in, conveyed them both off in safety.

LECTURE XLIX.

FISHES AND AQUATIC ANIMALS, *(continued)*.

THE COMMON EEL

Evidently forms a connecting link in the chain of nature, between the serpents and fishes, possessing not only, in a great measure, the serpent form, but also many of their habits.

It quits its element, and during night wanders along the meadows, not only in order to change its habitation, but also for the sake of prey, feeding on snails as it passes along. During winter it beds itself deep in the mud, and continues in a state like the serpent-kind. It is very impatient of cold, and will eagerly take shelter in a wisp of straw flung into a pond in severe weather, which has sometimes been practised as a method of taking them.* Albertus affirms, that he has known eels to take shelter in a hay-rick; yet all perished through excess of cold.

In the *Nen*, at Northampton, there is a variety of small eel, with a lesser head and narrower mouth than the common kind, found in clusters in the bottom of the river, and is called the *bed-eel;* these are sometimes roused up by the violent floods, and are never found at that time with meat in their stomach.

Eels are extremely voracious, and destructive to the fry of others. No fish lives so long as this out of water, and it is so extremely tenacious of life, that its parts will move long after they are flayed and cut in pieces. They vary much in their colours, from a sooty hue to a light olive green; and those called *silver eels* have their bellies white, with remarkable clearness throughout. Besides these, there is a variety of this fish in the Thames, known by the name of *grigs,* and about Oxford by that of *gluts.* These are scarcely ever seen near Oxford in the winter; but appear in spring, and bite readily at the hook, which common eels in that neighbourhood will not. They have a larger head, a blunter nose, thicker skin, and less fat, than the common sort; neither are they so much esteemed, nor do they often exceed three or four pounds in weight. Common eels grow to a large size, sometimes weighing fifteen or twenty pounds; but that is extremely rare. The Romans considered eels very common, probably on account of their likeness to snakes. On the contrary, the luxurious Sybarites were so fond of these fish, as to exempt from tribute of every kind those persons who sold them.

Though it is generally allowed that eels are produced like other animals, by parents of their own kind, yet many doubts remain concerning the manner of generation. Some allow them to be of different sexes in different individuals; which may be discovered on a careful inspection; and some are found to be males, and others females; but in both, the organs are buried in a large quantity of fat, whence the mistake of Aristotle and his followers, who, not being able to find those parts, concluded that they did not exist; and others affirm that they are all hermaphrodites, each having the peculiarities of both sexes. Leeuwenhoek says, that he found an uterus in every eel he examined; and therefore concludes, that they are hermaphrodites; and he supposes that they have no male parts of generation like those of other animals; but that the office of these is performed by a liquor analogous to the male seed of animals, which is contained in certain glands situated in the inside of the uterus. Rondeletius affirms that they are of both sexes; and Mr. Allan, who has given a very curious paper concerning them in the Philosophical Transactions, is of the same opinion. Among those who allow the eel to be produced, like other animals, from animal-parents which have the sexes, some have been of opinion that they are viviparous, and others that they are oviparous: but Chartwynd determined this controversy, by observing, that, if the aperture under the belly of the eel, which looks red in May, be cut open at that time, the young eels will be seen to come forth alive after the operation.

Eels have sometimes been met with in recent ponds, made at a great distance from any other water. Of the migration of young eels from one part of a river to another, an instance is related by Dr. Anderson:

"I one day observed (says he,) something like a black string, moving along the edge of the river Dee, in shoal-water. On closer inspection, I discovered that this was a shoal of young eels, so closely joined together as to appear like one continued body, moving briskly up against the stream. To avoid the retardation which they experienced from the force of the current, they kept close along the water's edge the whole of the way, following all the bendings and sinuosities of the river. Where they were embayed, and in still-water, the shoal dilated in breadth, so as sometimes to be nearly a foot broad; but, when they turned a cape, where the current was strong, they were forced to occupy less space, and to press close to the shore, struggling very hard till they passed it.

"This shoal continued to move on night and day, without interruption, for several weeks. Their progress might be at the rate of about a mile an hour. It was easy to catch the animals, though they were very active and nimble. They were eels, in every respect perfectly formed, but not exceeding two inches in length. I conceive that the shoal did not contain, on an average, less than from twelve to twenty in breadth; so that the number which passed, on the whole, during their progress, must have been very great. Whence they came, or whither they went, I know not. The place where I remarked them at was six miles from the sea, and I am told that the same phenomenon takes place every year about the same season."

Eels have frequently been known to destroy young ducks. Sir John Hawkins, from a canal near his house at Twickenham, missed many of the young ducks; and, on draining, in order to clean it, he discovered in the mud great numbers of large eels. In the stomachs of many of these were found, undigested, the heads and part of the bodies of the ducks.

The *conger*, or *conger-eel*, grows to a vast size, some having been taken near Mount's-bay, of 100lb. weight; and others near Scarborough that were ten feet long, and eighteen inches in circumference, where thickest. They differ from the common eel: their colour in general is darker; their eyes much larger in proportion. They are extremely voracious, preying on other fish, and on crabs at the time they have lost their shell and are in a soft state. They, and eels in general, are also particularly fond of carcasses of any kind, being frequently found lodged in such as are accidently taken up.

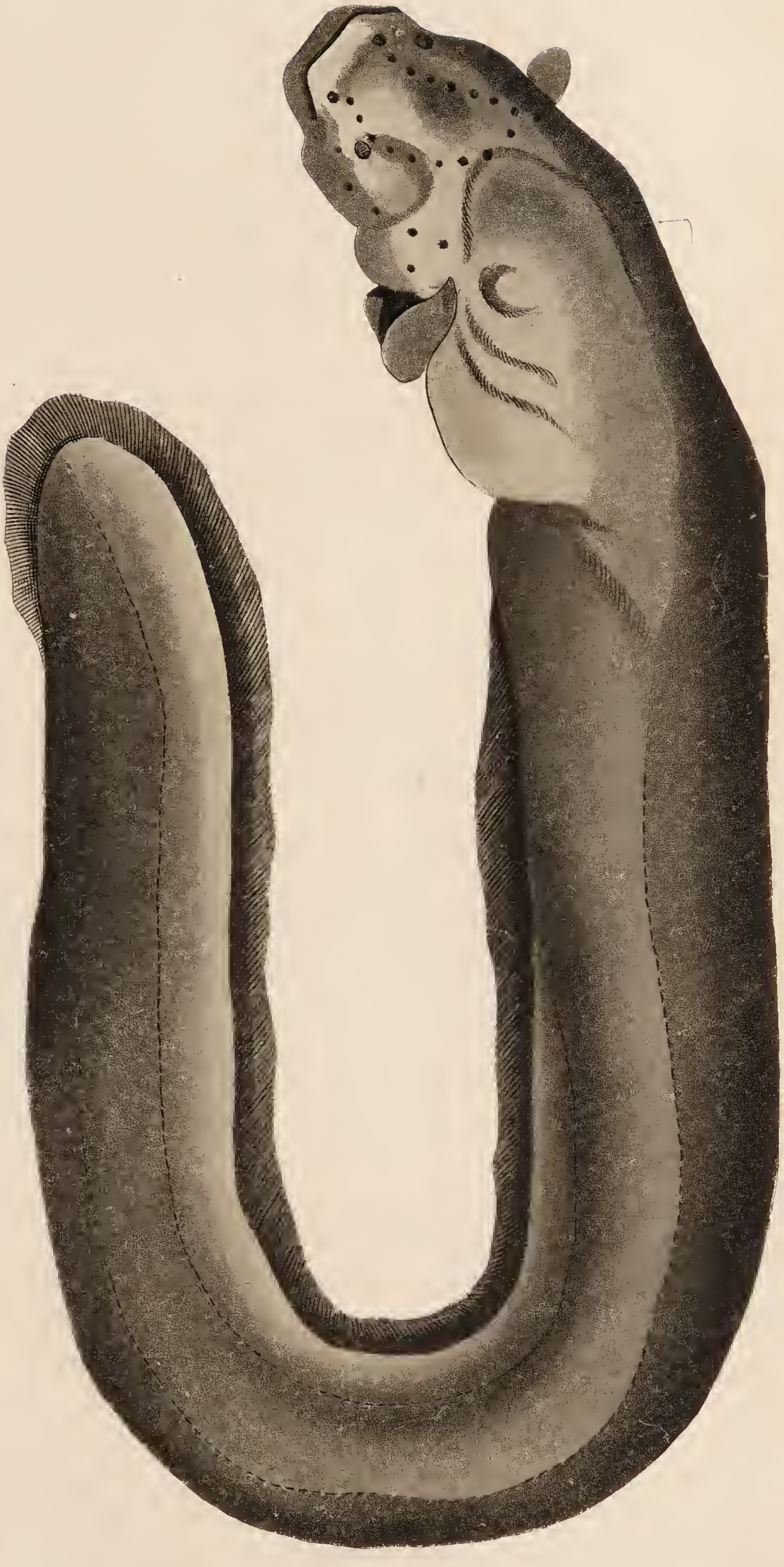
The conger-eels probably generate like the fresh-water species. Innumerable quantities of what are supposed to be their fry, come up the Severn about April, preceding the shads, which, it is conjectured, migrate into that river to feed on them: they are called *elvers*.

THE ELECTRICAL GYMNOTUS.

> Or arm in waves, electric in his ire,
> The dread Gymnotus with ethereal fire—
> Onward his course with waving tail he helms,
> And mimic lightnings scared the watery realms.
>
> DARWIN.

This resembles the common eel; is from three to four feet in length; and, in the thickest part of its body, ten or twelve inches in circumference. The head is flat, and the mouth wide and destitute of teeth. A fin, about two inches deep, extends from the point of its tail to within six inches of the head; and, where it joins the body, this fin is almost an inch thick. Across the body there are several annular divisions, or rather rugæ of the skin, from which the fish should seem to partake of a vermicular nature, and to have the power of contracting or dilating itself at pleasure. It is able to swim backward as well as forward. It is peculiar to South America, where it is found only in the rocky parts of rivers, at a great distance from the sea.

It possesses the singular property of giving a shock, (similar in its effects to that produced from a charged jar,) to any body, or any number of bodies connected together. Dr. Williamson says, that, on touching an electrical eel with one hand, a sensation is experienced similar to that arising from touching the conductor of an electrical machine; with a short iron rod the same was felt, but less powerfully. While another person provoked the fish, Dr. Williamson put his hand into the water, at the distance of three feet from it, and felt an unpleasant sensation in the joints of his fingers. Some small fish were thrown into the water, and the animal immediately stunned and swallowed them. A larger fish was thrown in, which he stunned likewise, and attempted to swallow, but, from its size, he could not effect it. Dr. Williamson put his hand into the water, and had another fish thrown in at some distance. The eel swam up to it, and at first turned away without offering it any violence: after a little time he returned, and, looking stedfastly at it for a few seconds, gave it a shock, by which it instantly turned upon its back, and became motionless. Dr. Williamson, at that very instant, felt the same sensation in his fingers, as he had done when he put his hand into the water before. A fish was afterwards struck, but not quite killed: when the electric eel perceived this, he returned, and by a second shock, evidently more severe than the former, rendered it motionless. On touching the eel with one hand, so as to provoke it, and holding the other in the water at a little distance, a severe shock was felt through both the arms, and across the breast, similar to that from a charged jar. Eight or ten persons, with their hands joined, experienced the same, on the first touching the head, and the last the tail of the fish. A dog, being made a link in this chain, uttered a loud yell at the instant of contact. When the eel was touched with silk, glass,



ELECTRICAL GYMNOTUS.

or any other non-conductor, no shock was felt. From a long series of experiments, it appeared to Dr. Williamson that these properties partook so nearly of the nature of electricity, that whatever would convey the electrical fluid would also convey the fluid discharged by the eel; and *vice versa.* He, however, was not able to observe that any spark was produced on contact. This mode of defence the fish never adopted except it was irritated; and Dr. Williamson has passed his hand along the back and sides from head to tail, and has even lifted part of its body out of the water, without exciting it to injure him.

Instances have occurred of persons being knocked down with the stroke. An English sailor once insisted on taking it up; but, the moment he grasped it, he dropped down in a fit; his eyes were fixed; his face became livid; and it was not without difficulty that his senses were restored. He said that the instant he touched it, " the cold ran swiftly up his arm into his body, and pierced him to the heart." A negro, who attempted with his hands to grasp a large fish, had, in consequence, a confirmed paralysis in both his arms.

This electrical property seems principally of use to these eels in securing their food, as they are destitute of teeth. The force of the shock has been satisfactorily proved to depend entirely on the will, and to be exerted as circumstances require. Their prey are generally so stunned by the shock, as to appear dead; but, when these have been taken into another vessel, they have been always found to recover.

> The organs which produce this wonderful accumulation of electric matter, (says Mr. Bingley,) constitute nearly one half of that part of the flesh in which they are placed, and perhaps, compose more than one-third of the whole animal. There are two pairs of these organs, one on each side. Their structure is very simple and regular, consisting only of flat partitions, with cross divisions between them. The partitions are thin membranes, placed nearly parallel to one another, and of different lengths and breadths. Their distances from each other differ with the size of the fish: in one of two-feet four-inches in length, they were found to be

the $\frac{1}{32}$nd part of an inch asunder. They appear to answer the same purpose as the columns of the torpedo, making walls or butments for the subdivisions, and are to be considered of forming so many distinct organs: they are so tender as to be easily lacerated.

THE CORDATED EEL.

This fish inhabits the West-Indian seas. Its whole length is about thirty-two inches, of which the process at the end of the tail measures twenty-two. The snout is connected to the back part of the head by a flexible leathery duplicature, which permits it to be extended so that the mouth points upwards, or to fall back so as to be received into a sort of case, formed by the upper part of the head. The body gradually diminishes as it approaches the tail, which terminates in a process or string of enormous length, ending in a very fine point.

THE COMMON COD.

Before the discovery of Newfoundland, the principal fisheries for cod were in the seas off Iceland, and off the western islands of Scotland. To the former of these the English navigators resorted nearly 400 years ago: in the reign of James the First, we had no fewer than 150 vessels employed in the Iceland fishery

The chief fisheries now are in the Bay of Canada, on the great bank of Newfoundland, and off the isle of St. Peter and the isle of Sable. The vessels frequenting these fisheries are from a hundred to two hundred tons burden, and will catch 30,000 cod or upwards each. The hook and line are the only implements employed in taking the fish, and this in a depth of water from sixteen to sixty fathoms. The great bank of Newfoundland is represented to be like a vast mountain, above 500 miles long, and nearly 300 broad; and the number of British seamen employed upon it is supposed to be about 15,000.

In Lapland, and some of the districts of Norway, the cod and torsk, which are caught in the winter, are carefully piled up, as they are caught, in buildings constructed for the purpose. Here they remain frozen until the following spring, when they are removed to another building, in which they are prepared for drying. The heads are cut off, the entrails taken out, and the remainder of the body is hung up in the air.

Cod feed principally on the smaller species of fish, on worms, shell-fish, and crabs; and their digestion is sufficiently powerful to dissolve the greatest part even of the shells which they swallow.

Cod frequently grow to a very great size. The largest that is known to have been taken in this kingdom was caught at Scarborough, in the year 1775: it measured five feet eight inches in length, and five feet in circumference, and weighed seventy-eight pounds. The usual weight of these fish is from fourteen to forty pounds.

Fishermen are well acquainted with the use of the air-bladder or sound of the cod, and are very dexterous in perforating this part of a live fish with a needle, in order to disengage the inclosed air; for without this operation it could not be kept under water in the well-boats, and brought fresh to market. The sounds of the cod salted is a delicacy often brought from Newfoundland. Isinglass is also made of this part by the Iceland fishermen; a process which deserves the attention of the natives of the north of Scotland, where these fish are plentiful.

THE SWORD-FISH

Sometimes visits the British seas, the North seas, and the Baltic; but is much more common in the Mediterranean. In spring they come towards the coasts of Sicily, where, at the bottom of the water, they lay their eggs in great quantities. According to the late Sir W. Hamilton, they are never more than three or four feet long in that country; but the large fish, which weigh between four and five hundred pounds, are found towards the coast of Calabria.

When the ship Leopard, after her return from the coast of Guinea and the West Indies, was ordered, in 1725, to be cleaned and refitted for the Channel service, in stripping off her sheathing, the shipwrights found in her bottom, pointing in a direction from the stern towards the head, part of the sword or snout of one of these fishes. On the outside, this was rough, not unlike seal-skin; and the end, where it was broken off, appeared like a coarse kind of ivory. The fish, from the direction in which the sword lay, is supposed to have followed the ship when under sail. The weapon had penetrated through the sheathing, which was an inch thick; had passed through three inches of plank, and, beyond that, four inches and a half into the timber. The force requisite to effect this must have been excessively great, especially as no shock was felt by the persons on-board.

A few years ago, a letter from the captain of an East-Indiaman communicated an account of another instance of the amazing strength which this fish occasionally exerts. The bottom of his ship had been pierced through in such a manner, that the sword was completely imbedded, or driven through its whole length, and the fish killed by the violence of the effort. A part of the bottom of the vessel, with the sword imbedded in it, is now deposited in the British Museum.

Violent battles frequently occur between the sword-fish and the whale. The whale employs his tail only in his defence, an effectual blow from which generally finishes the sword-fish; but the latter, being the most adroit, often falls upon the whale, and buries his weapon in its sides.

THE SUCKING FISH.

There are only three known species of the sucking-fish; these are occasionally seen in the Mediterranean sea and the Pacific ocean. The common sucking-fish, which inhabits most parts of the ocean, is usually about a foot in length; the head is large, equal in bulk to the body, which grows smaller gradually to the tail.

The sucking-fish, in almost all ages, has ranked high in the writings of poets, in the comparisons of orators, the narrations of travellers, and the descriptions of naturalists. The ancients absurdly believed that, small as it is, this fish had the power of arresting the progress of a ship in its fastest sailing, by adhering to its bottom:

> The sucking-fish beneath, with secret chains,
> Clung to the keel, the swiftest ship detains.
> The seamen run confus'd, no labour spar'd,
> Let fly the sheets, and hoist the top-mast yard.
> The master bids them give her all the sails,
> To court the winds, and catch the coming gales.
> But, though the canvass bellies with the blast,
> And boisterous winds bend down the cracking mast,
> The bark stands firmly rooted in the sea,
> And will, unmov'd, nor winds nor waves obey;
> Still, as when calms have flatted all the plain,
> And infant waves scarce wrinkle on the main,

No ship in harbour moor'd so careless rides,
When ruffling waters tell the flowing tides.
Appall'd, the sailors stare, through strange surprise,
Believe they dream, and rub their waking eyes.
As when, unerring from the huntsman's bow,
The feather'd death arrests the flying doe,
Struck through, the dying beast falls sudden down,
The parts grow stiff, and all the motion's gone;
Such sudden force the floating captive binds,
Though beat by waves and urged by driving winds.

Five of these fish have been taken off the body of a single shark. St. Pierre says, he has put some of them on an even surface of glass, from which he could not afterwards remove them.

THE SALMON

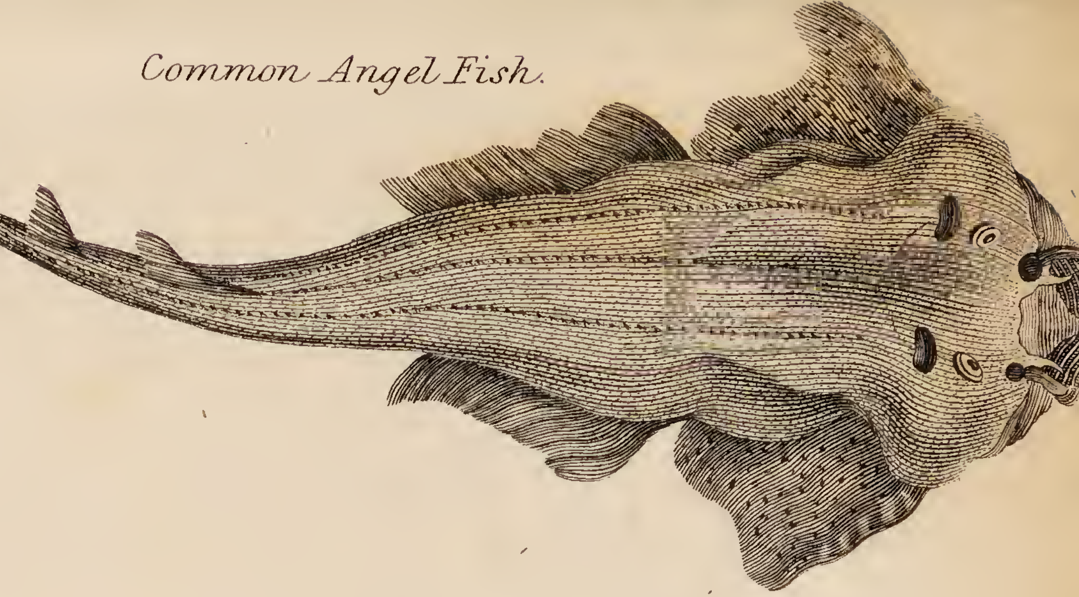
Frequents the northern regions alone. It is unknown in the Mediterranean sea, and in all the rivers which fall into it. It is found in some of the rivers of France that empty themselves into the ocean. Salmons are taken in the rivers of Kamtschatka, and appear as far north as Greenland. They live both in the ocean and in fresh waters. To deposit their spawn, they quit the sea in the month of September, and ascend the rivers. So strong is the instinct of migrating, that they press up the rivers with amazing keenness, and scarcely any obstacle is sufficient to interrupt their progress. They spring, with great agility, over cataracts several feet in height. When they find a place which they think proper for depositing their eggs, the male and female unite their labours in forming a convenient receptacle for the spawn in the sand, which is generally about eighteen inches deep. In this hole the female deposits her eggs, and the male his milt, which they are said to cover carefully with their tails; for, after spawning, their tails are deprived of skin. The eggs, when not disturbed by violent floods, lie buried in the sand till the spring, and they are hatched about the end of March. The parents, however, after this important office has been performed, hasten back to the sea, in order to cleanse themselves, and to recover their strength. Toward the end of March, the young fry begin to appear, and they gradually increase in size till they acquire the length of four or five inches, and are then called smelts or smoults. In the beginning of May, all the considerable rivers of Scotland are full of salmon-fry; and, after this period, they migrate to the sea. About the middle of June, the earliest of the fry begin to appear again in the rivers. At that time they are from twelve to sixteen inches long, and gradually augment, both in number and size, till about the end of July, or the beginning of August, when they weigh from six to nine pounds.

A salmon, weighing seven pounds and three-quarters, was taken on the seventh day of February. It was marked on the back, fin, and tail, with scissars, and then turned into the river. It was retaken on the 17th day of the following month of March, and then it weighed seventeen pounds and a half. The season for fishing salmon in the Tweed begins on the 30th of November, and ends on Old Michaelmas-day. In that single river, it is computed that no less than 208,000, at a medium, are annually caught, which, together with the products of many other rivers on both sides of Scotland, not only afford a wholesome and palatable food to the inhabitants, but also form a considerable article of commerce.

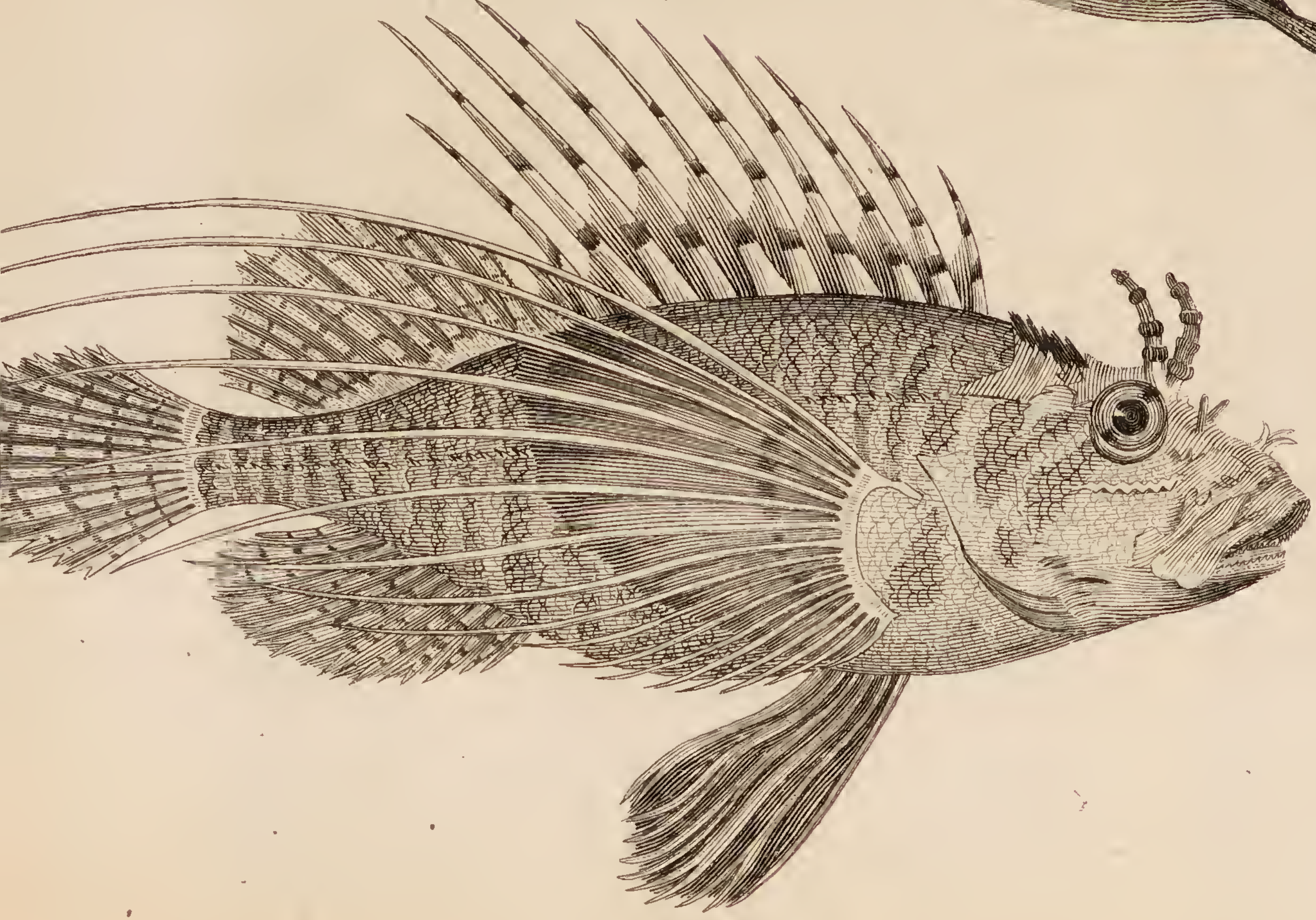
On the river Liffey, in Ireland, is a cataract about nineteen feet high: here, in the salmon season, many of the inhabitants amuse themselves in observing the fish leap up the torrent. They frequently fall back many times before they surmount it; and baskets, made of twigs, are placed near the edge of the stream, to catch them in their fall. At the falls of Kilmorack, in Scotland, where the salmon are very numerous, it is a common practice with the country people to lay branches of trees on the edges of the rocks: by this means they sometimes catch such of the fish as miss their leap, which the foaming of the torrent not unfrequently causes them to do. The late Lord Lovat, who often visited these falls, taking the hint from this circumstance, formed a determination to try a cruel experiment on the same principle. He ordered a kettle full of water to be placed over a fire, beside one of the falls; and many minutes had not elapsed before a large salmon made a false leap, and fell into it.

THE FLYING FISH.

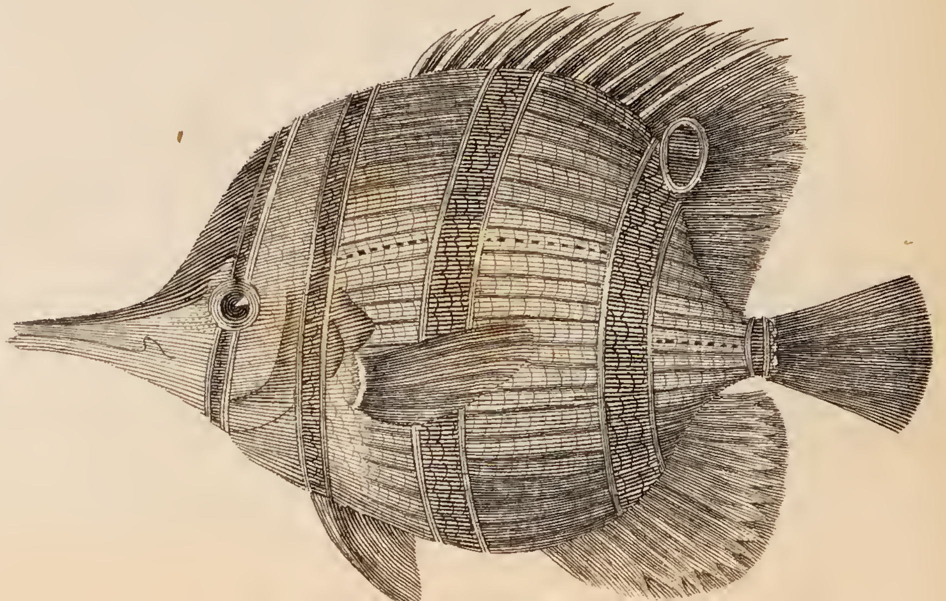
The winged flying fish, except its head and flat back, has, in the form of its body, a great resemblance to the herring. It is generally nine inches long, and full four round at the thickest part. The skin is extremely firm, and the scales are long and silvery. The pectoral fins are very long; and the dorsal fin is small, and placed near the tail, which is forked: the eye, in consequence of the largeness of the head, is admirably situated for discovering danger or prey; and



Common Angel Fish.



Horned Scorpæna.



Horned Chætodon.

when pushed out of the socket, which the fish can do considerably, its sphere of vision is greatly increased.

The flying-fish inhabits the European, the American, and the Red Seas: but is chiefly found within the tropics. The wings, with which they have the power of raising themselves into the air, are nothing more than large pectoral fins, composed of seven or eight ribs, or rays, connected by a flexible, transparent, and glutinous membrane.

The flying-fish has numerous enemies in its own element; the dorado, the thunny, and many others, pursue and devour it. In its flight, it is often seized by the albatross or tropic birds. It seldom flies more than sixty or seventy yards at a time; but, by touching the surface at intervals, to moisten its fins, it is able to double or treble this distance. The whole flight, however, is of so short a duration, that, even in the hottest weather, its fins do not become dry. By touching the water, it not only wets its fins, but seems to take fresh force and vigour, for another spring into an element in which it is not long able to support its weight.

THE HERRING.

Herrings are chiefly confined to the northern and temperate regions of the globe. They frequent the highest latitudes, and are sometimes found on the northern coasts of France. They appear in vast shoals on the coast of America, as far south as Carolina.

In Chesapeak bay there is an annual inundation of herrings; and they cover the shores in such amazing numbers as to become offensive to the inhabitants. The great winter rendezvous of the herrings is within, or near, the Arctic circle, where they remain several months, and acquire strength after being weakened by the fatigues of spawning, and of a long migration. In these seas, insect-food is much more abundant than in warmer latitudes. They begin their migration southward in the spring, and appear off Shetland in April and May. These, however, are only the forerunners of the immense shoal which arrives in June. Their approach is recognised by particular signs, such as the appearance of certain fishes, the vast number of birds, as gannets or soland geese, which follow the shoal to prey upon the herrings. But, when the main body arrives, its breadth and depth are so great, as to change the appearance of the ocean itself.

The shoal is generally divided into columns of five or six miles in length, and three or four in breadth. Their progressive motion creates a kind of rippling or small undulations in the water. They sometimes sink and disappear for ten or fifteen minutes, and then rise again toward the surface. When the sun shines, a variety of splendid and beautiful colours are reflected from their bodies. In their progress southward, the first interruption they meet with is from the Shetland islands. Here the shoal divides into two branches. One branch skirts the eastern, and the other the western shores of Great Britain, and fill every bay and creek with their numbers. Those which proceed to the west from Shetland, after visiting the Hebrides, where the great fishery is carried on, move on till they are again interrupted by the north of Ireland, which obliges them to divide a second time. One division takes to the west, where they are scarcely perceived, being soon lost in the immensity of the Atlantic ocean, and the other division goes into the Irish sea. The chief object of herrings migrating southward, is to deposit their spawn in warmer and more shallow seas than those of the frigid zone. This instinct seems not to be prompted by a scarcity of food; for, when they arrive upon our coasts, they are fat and in fine condition; but, when returning to the ocean, they are weak and emaciated.

They continue in perfection from the end of June to the beginning of winter, when they begin to deposit their spawn. The great stations of the herring fisheries are off the Shetland and the Western islands, and along the coast of Norfolk.

Herrings once swarmed so excessively on the west side of the isle of Skye, that the numbers caught were more than could possibly be carried away. After the boats were all loaded, and the country round was served, the neighbouring farmers made them up into composts, and manured their ground with them in the ensuing season. This shoal continued to frequent the coast for many years.

Thirty years ago, herrings came into Loch Urn in such shoals, that from the narrows to the head, about two miles, it was quite full. Such numbers were pushed on shore, that the beach, for four miles round the head, was covered with them, to the depth of from six to eighteen inches; together with the ground under water, as far as could be seen when the tide was out. Indeed so thick and so forcible was the shoal, as to carry before it every other kind of fish; and ground-fish, skate, flounders, &c. were driven on the shore with the first of the herrings, and perished there.

THE GOLD FISH.

These beautiful fish are natives of China; and the most beautiful kinds are caught in a small lake in the province of Chekyang, at the foot of a mountain called Tsyen-king.

In China they are kept in ponds, or large porcelain vessels, by almost every person of distinction; but they are so delicate, that, if cannon are fired, or any substances giving out a powerful smell, as pitch or tar, are burned near them, great numbers will be killed. They are fed with balls of paste, and the yolks of eggs boiled very hard. In England, many persons are of opinion that they need no aliment. It is true that they will subsist for a long while without any other food than what they can collect from water frequently changed; yet they must draw some support from animalcules and other nourishment supplied by the water.

When gold-fish are kept in ponds, they are often taught to rise to the surface of the water at the sound of a bell, to be fed. At Pekin, for three or four months of the winter, or whilst the cold weather lasts, the fish in the ponds are not fed at all. They are able, during that time, to obtain the small quantity of food which they require from the water. In order to prevent their being frozen, they are often taken into the houses, and kept in china vessels, till the warm weather of spring allows their being returned to their ponds with safety.

They were first introduced into England in 1691; but they were not generally known till thirty years afterwards.

SHARKS.

These creatures are the dread of sailors in all the hot climates; for they constantly attend ships, in expectation of what may be thrown overboard.

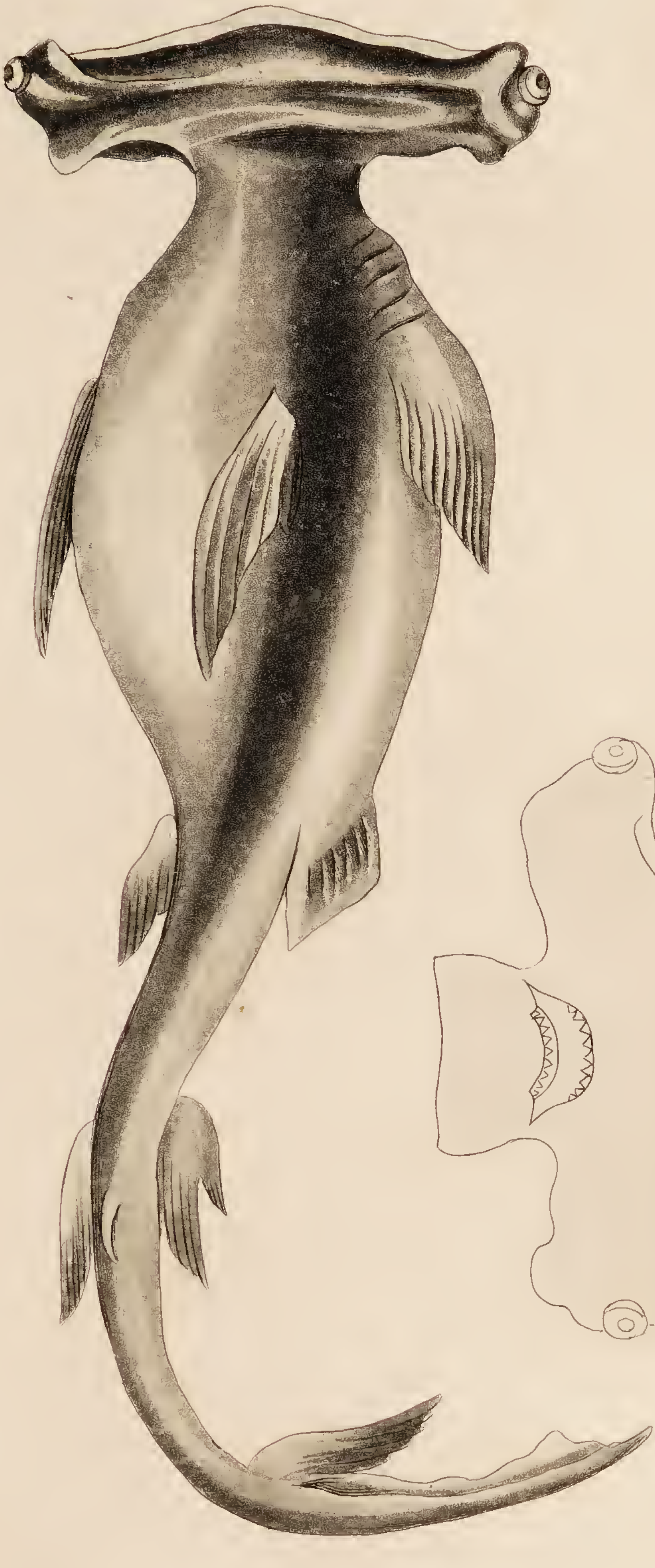
Increasing still the terrors of the storms,
His jaws horrific arm'd with threefold fate,
Here dwells the direful shark. Lured by the scent
Of streaming crowds, of rank disease, and death,
Behold! he rushing cuts the briny flood,
Swift as the gale can bear the ship along;
And, from the partners of that cruel trade
Which spoils unhappy Guinea of her sons,
Demands his share of prey, demands themselves.
The stormy fates descend, one death involves
Tyrants and slaves; when straight, their mangled limbs
Crashing at once, he dyes the purple seas
With gore, and riots in the vengeful meal.

A rage for suicide has been known to prevail among slaves, from an opinion entertained by the unfortunate wretches that, after death, they should be restored to their families, friends, and country. To convince them that their bodies could never be re-animated, the corpse of one that was just dead was tied by the heels to a rope, and lowered into the sea. It was drawn up again as quickly as the united force of the crew could do it; yet, in that short time, the sharks had devoured every part but the feet, which were secured by the end of the cord.

The WHITE SHARK is often thirty feet long. The mouth is sometimes furnished with a six-fold row of teeth, flat, triangular, exceedingly sharp at their edges, and finely serrated. Mr. Pennant had one tooth rather more than an inch and a half long. Grew says, those in the jaws of a shark two yards long, are not half an inch; so that the fish to which this tooth belonged must have been six yards long, provided the teeth and body keep pace in their growth.

This dreadful apparatus, when the fish is in a state of repose, lies quite flat in the mouth; but, to seize his prey, he can erect them, by a set of muscles which join them to the jaw. The mouth is placed far beneath; for which reason these fish turn on their backs to seize their prey. The eyes are large; the back broad, flat, and shorter than that of other sharks. The tail is semilunar, the upper part longer than the lower. It has vast strength in the tail, and can strike with great force; hence sailors, when they draw one on-board, instantly cut it off with an axe. The pectoral fins are very large, enabling it to swim with great swiftness. The colour of the whole body and fins is of a light ash.

Part of the crew of an English merchant-ship were once bathing in the sea, when a large shark appeared, and sprung forward directly at them. Being warned of their danger, they all reached the vessel in perfect safety, except one man, who was cut in two by the shark, almost within reach of the oars. The insatiable shark was seen traversing the bloody surface in search of the remainder of his prey, when a comrade of the victim plunged into the water, determining either to make the shark disgorge, or to be buried himself in the same grave. He held in his hand a long and sharp-pointed knife, and the rapacious animal pushed furiously towards him: he had turned on his side, and had opened his enormous jaws, in order to seize him, when the youth,



HAMMER HEADED SHARK.

London Published by Sir R.Phillips & Co. Feb.10.1823.

diving dexterously under, seized him with his left hand, below the upper fins, and stabbed him several times in the belly. The shark now plunged in all directions, to disengage himself from his enemy; and, being weakened by loss of blood, made towards the land, and with him his conqueror; who pushed his foe with redoubled ardour, and dragged him on shore. Here he ripped up the bowels of the animal, obtained the severed remainder of his friend's body, and buried it with the trunk in the same grave.

The South-Sea islanders are not in the least afraid of the sharks. "I have seen," says Captain Portlock, "five or six large sharks swimming about the ship, when there have been upwards of a hundred Indians in the water, both men and women: they seemed quite indifferent respecting them, and the sharks never offered to make an attack on any of these people, and yet at the same time would greedily seize our baits."

In 1782, when the Cæsar, a French ship of the line, was set on fire, the sailors threw themselves into the sea: Sir Charles Douglas observed great numbers of these sharks, which lay between the French and British fleets, instantly seize on the unhappy victims: and, such is the voracity of these animals, that he several times saw two of them disputing about their prey, each seizing a leg, and at length disappearing, dragging the body along with them.

The BASKING SHARKS frequent our seas during the warm summer-months, and are not uncommon on the Welsh and Scottish coasts, coming in shoals usually after intervals of a certain number of years. In the intervening summers, those that are seen on the Welsh coast, are generally single fish, that have probably strayed from the rest. They appear in the Firth of Clyde, and among the Hebrides, about midsummer, in small droves of seven or eight, or more commonly in pairs. Here they continue till the latter end of July, when they disappear.

The HAMMER-HEADED SHARK, of which we have introduced an engraving, grows to the length of six feet, and is principally seen in the Mediterranean.

THE TORPEDO.

Of the different species of ray, the torpedo cramp fish, or electric ray, is the most remarkable, because it possesses some very distinguishing peculiarities. The general structure of its body does not differ materially from other rays: the electric, or benumbing organs, are placed one on each side of the gills, reaching thence to the semicircular cartilages of each great fin, and extending longitudinally from the interior extremity of the animal, to the transverse cartilage which divides the thorax from the abdomen; and within these limits they occupy the whole space between the skin of the upper and under surfaces: each organ is about five inches in length; and, at the anterior end, about three in breadth; they are composed of perpendicular columns, reaching from the upper to the under surface, varying in length according to the thickness of the parts of the body, from an inch and a half to half an inch.

The coats of the columns are very thin, and almost transparent. The number of columns in each organ varies considerably in different animals. That of one which Mr. Hunter presented to the Royal Society, was about 470; but, in a very large torpedo, the number of columns in one organ was 1182. These columns were composed of films parallel to the base of each, and the distance between each of the columns was the 150th part of an inch. If we suppose these films to be charged with electricity, and to be the 300th part of an inch thick, and a middling-sized torpedo to contain in both organs, on the whole, 1000 columns each, an inch long, and 0·03 square inches area at the base, then $1000 \times 150 \times 0.3 = 4500$ square inches. Now it has been clearly proved, that the capacity of stout glass is thirty-six times less than that of these organs; therefore both the organs of a middling-sized torpedo will be equivalent to $4500 \times 36 = 162{,}000$ square inches, or 1125 square feet of glass. The nerves inserted into each organ arise by three very large trunks from the lateral and posterior part of the brain. These, having entered the organs, ramify in every direction between the columns. Their number and magnitude are extremely great; and it is supposed that they are subservient to the formation, collection, and management of the torpedinal fluid.

The head and body of the torpedo are distinct from each other, and nearly of a circular form; the skin is smooth, of a dusky brown colour above, and white underneath; the ventral fins form on each side, at the end of the body, nearly a quarter of a circle: the tail is short, and the dorsal fins are placed near its origin:

the mouth is small, and, as in other species, there are on each side below it five breathing apertures.

The electric rays are found in many of the European seas, and the fishermen often discover it in Torbay, and sometimes of such a size as to weigh eighty pounds. They are partial to sandy bottoms, in about forty fathoms of water, where they often bury themselves by flinging the sand over them.

This fish's benumbing or torporific quality is one of the most potent and extraordinary faculties in nature. The ignorant stranger might imagine he is only handling a skate, when he is instantly struck numb.—Upon touching the torpedo with the finger, it frequently, though not always, happens, that the person feels an unusual pain and numbness, which suddenly seizes the arm up to the elbow, and sometimes to the very shoulder, or head.

Dr. Ingenhousz had for some time, in a tub of sea-water, a torpedo, which, from its being during winter, seemed to be feeble. On pressing it on each side of the head, a sudden tremor, which lasted for two or three seconds, passed into his fingers, but extended no further. After a few seconds, the same trembling was felt again; and again several times, after different intervals. The sensation, he says, was similar to that which he should have felt by the discharge of several small electrical bottles. The shocks sometimes followed each other very quickly, and increased in strength towards the last. A coated vial was applied to it, but could not be charged.

THE PORCUPINE FISH.

This species is found not only in America, but in the Red Sea, and near the shores of Japan. At New York, where it appears only in the summer-months, the natives fish for them, by throwing in a line baited with the tail of a sea-crab; the fish approaches, but, being afraid of the line, it makes several turns and trials round the bait, and at length nibbles at it, but pretends to reject it, and passes by, striking it with its tail, as if it did not regard it: but, if the rod be kept steady, it presently turns back, seizes the bait, and swallows hook and all. When it finds itself taken, it becomes enraged, bristles up its spines, swells out its belly, and endeavours to wound every thing near it. Finding this of no avail, it resorts to cunning, and seems to submit; it lowers its spines, contracts its body, and lies like a wet glove. But this artifice not succeeding, and perceiving the fisherman dragging it towards the land, it renews its defensive attitude with redoubled fury. The spines are now vigorously erected, its form rounded, and its body so completely armed at all points, that it is impossible to take it by the hand; it is therefore dragged to some distance, where it struggles and quickly dies.

THE ESCHINUS, OR SEA-URCHIN.

This species of the sea-urchin is numerous; its shape is hemispherical, oval, with ten winding avenues; the spaces between each are armed with strong prickles and warts. It inhabits the Southern Seas; and is valued as a nourishing and savoury food. Most of this species of fish have a great variety of beautiful tints and curious forms, many of which are highly valued in collections.

On the coast of Perry, near St. Clara, and also at Malacca, is found the Cat-fish, whose fins are venomous: several Indians having been pricked with them, some lost the use of their limbs, and others their lives. It is far from being of a disagreeable flavour; and it is remarkable, that it is not found at any of the islands, east or west, by which it has passed.

Mr. Bucke mentions a very curious fish, which he thinks not improbable is one cause of pearls being found in oysters. At Sydney, in 1817, a party at supper witnessed the opening of an oyster, in which lay a cartilaginous fish, about two inches long, curled up in the bed of the late inhabitant, which it, doubtless, had destroyed. It sprung upon the table, and was preserved alive several hours; and, placed between the eye and the sun, appeared wholly transparent; the body had stripes of brown and yellow, forming altogether a very beautiful little animal. That this fish, residing in a foreign shell, had the oyster been able to destroy it, instead of the contrary, is not probable; but that some aqueous animal may intrude itself into the shell, and there crystallize, is not improbable